MILK AND FOOD SANITATION PRACTICE

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PREFACE

As LECTURER at the School of Public Health, University of Minnesota, the author has felt a need for a text in the field of milk and food sanitation that would combine theory and practice. This book is an outgrowth of that need. It attempts to bridge the gap between what should be done and how to do it. It is intended that it should be useful in orienting the public health student who plans to work in the field of environmental sanitation, and that it should serve as a guide for health officers, public health engineers, and sanitarians whose work in a local health department involves the routine but important duties in the sanitary supervision of milk and food supplies. The book endeavors to present essential and fundamental principles of milk and food control, but it does not attempt to discuss theory exhaustively. It is hoped that the student and the worker alike will find suggestions in it that will make their work more effective and more meaningful.

Modern milk and food control programs emphasize an educational approach as a productive means of advancing sanitation. Classes of instruction for dairymen, milk plant operators, restaurant proprietors, and food handlers offer an excellent opportunity for imparting valuable information to these and other groups. The prominent place instruction plays in an environmental sanitation program has been stressed either directly or by implication in many parts of this book, and in the author's judgment such means of promoting sanitation should always occupy a foremost place in program planning.

References to the literature are intended to be representative rather than exhaustive. In a text such as this it would be impracticable to give the opinions and viewpoints of all persons who have contributed to the vast amount of information in the field. It is assumed that those actively engaged in milk and food sanitation will consult other texts, scientific journals, and special bulletins when additional details are desired, since no single text can encompass the entire field. Furthermore, constant reference to current literature is necessary if one is to keep informed of new methods and techniques as they are developed.

The author wishes especially to express his appreciation to other workers in milk and food control for their critical study of the manu-

script and for their most helpful comments and suggestions: to W. S. Feagan, Public Health Engineer and formerly Chief of the Dairy Section of the Kansas City, Missouri, Health Department, and to H. E. Eagan, formerly assigned to the Mississippi State Board of Health, for assistance with the chapters dealing with milk control; to Ferdinand A. Korff, Director of the Bureau of Food Control of the Baltimore, Maryland, City Health Department, for advice on the food control section; to Roy J. Morton, Professor of Sanitary Engineering, Department of Preventive Medicine and Public Health, Vanderbilt University, for assistance in the development of outlines and early plans for the text. The author is also indebted to manufacturers of dairy and food equipment for many of the illustrations appearing in the text.

It is hoped that this book will prove useful to the many diligent public health workers whose day-to-day duties are so important to the promotion and protection of the public health.

H. S. Adams

Minneapolis, Minnesota
January, 1947

CONTENTS

MILK SANITATION

FOOD SANITATION

TABLES

FIGURES

I

HISTORY AND PUBLIC HEALTH IMPORTANCE OF MILK CONTROL

THE GENERAL improvement in the sanitary quality and safety of milk during the past few decades has served as a milestone of accomplishment in the promotion of public health. Yet milk sanitation as practiced today, even in localities where it has enjoyed unhampered and wholesome development, is of relatively recent origin. Our present era of milk control began with the publication in 1892 of the paper by Sedgwick and Batchelder on "A Bacteriological Examination of the Boston Milk Supply."[16] This early study showed the relation between the bacterial content and the sanitary quality of market milk.

To add further impetus to improvement in milk quality, Dr. Henry L. Coit,[1] of Newark, New Jersey, formulated in 1892 a plan whereby he and his colleagues might obtain for infant feeding a supply of clean, safe, wholesome milk, the best that knowledge of the time could produce. At Dr. Coit's suggestion, the Essex County Medical Society appointed a committee to make an investigation of the existing milk supply in relation to its effect upon public health. This committee submitted its report condemning many of the methods then employed in the production and handling of milk. An appeal was next made to the state legislature for funds to establish a system of dairy inspection and to hire personnel to carry on the work, but the appeal went unheeded, the legislature pleading lack of funds. Undaunted, Dr. Coit went ahead with plans and organized in April 1894 the Medical Milk Commission of the Essex County Medical Society. Thus was initiated one of the earliest recorded attempts to improve the sanitary quality of milk. The movement progressed and other commissions were formed; in 1907 they federated to become the American Association of Medical Milk Commissions, with the purpose of adopting uniform methods and standards for the production of certified milk and extending the movement throughout the country. The work of this organization has markedly influenced the sanitary quality of milk produced in this country, and many of its rules for sanitary milk production have been incorporated in modern milk legislation.

In the City of New York at about this same time, Nathan Straus,[75] a man of great humanitarian ideals, began a vigorous campaign against the intolerable conditions surrounding the production and handling of milk sold in that city. With the aid and counsel of faithful friends, he worked untiringly to improve milk quality as a means of safeguarding the health and lives of infants and small children. His investigations disclosed that infants were dying by the hundreds during the hot summer months because the milk fed them was contaminated, adulterated, and dangerous. Straus's ardent desire was to reduce infant mortality, and he realized that this could be accomplished through pasteurization. But even before pasteurization was officially adopted in New York City, the Nathan Straus Pasteurized Milk Laboratories became an institution and were heavily patronized by mothers anxious to obtain safe milk for their babies and young children. Straus's persistent efforts in behalf of pasteurized milk eventually succeeded, for on November 13, 1914, Dr. S. S. Goldwater, then Commissioner of Health for the City of New York, ordered pasteurization of the city's entire milk supply. Nathan Straus's desire to safeguard New York's milk and that of other large communities is an epic in the annals of milk sanitation and public health. Although pasteurization is now almost universally accepted as an essential process for safeguarding milk, its general acceptance has been achieved, in many instances, against strenuous opposition of special interests, politicians, and others whose reasoning ignored sound scientific facts and was largely emotional.

While pasteurization was gradually gaining recognition in many of the larger centers of this country, the control of milk supplies generally was in a chaotic condition, with little semblance of uniformity in sanitation requirements. The seriousness of this situation, coupled with the fact that milk-borne outbreaks of disease were frequent, prompted many health officials to regard milk sanitation as an increasingly vital component of public health protection. One of the first states to recognize the need for uniformity was Alabama. In 1923 it requested the United States Public Health Service to work with it on a cooperative basis to formulate and execute a state-wide milk program. Such a program was instituted under the direction of S. W. Welch, State Health Officer, and C. A. Abele, Director of the Bureau of Inspection. The late Leslie C. Frank, then Associate Sani-

tary Engineer for the United States Public Health Service, was assigned to carry out the project. As a result of the efforts of Mr. Frank and the Alabama officials, a standard milk ordinance was promulgated. The first printed edition of this ordinance appeared in the Public Health Reports of November 7, 1924. Since that date the ordinance has been changed and revised many times to keep pace with new developments and technological improvements in the handling and processing of milk; all revisions are acted upon by a board of consultants, first appointed about 1932 and now known as the Public Health Service Sanitation Advisory Board. The Standard Milk Ordinance recommended by the United States Public Health Service has done more to guide the thinking of milk sanitarians generally and to establish uniformity in milk legislation than any other document,* and mention of the progress made in the field of milk control would not be complete without recognition of the work done by Leslie Frank and the several members of the Advisory Board. However, the need for uniformity in milk control legislation is still an acute problem, and there are too many communities attempting to regulate milk sanitation with old and outmoded ordinances which fail to emphasize essentials, omit them altogether, or place undue stress upon requirements of little public health value.

THE NUTRITIVE VALUE OF MILK

A quart of milk provides all of the calcium needed by an individual for one day, all or practically all of the phosphorus, a liberal amount of vitamins A and G, one-third or more of the protein, one-eighth or more of the iron, at least one-fourth of the energy, and some of vitamins B, C and D. Considerable evidence has been accumulated to indicate that a diet composed predominantly of milk and dairy products increases the life span and promotes virility and fertility. Dr. Robert McCarrison[19] of the British Medical Service tells of a race of people in the Himalayas with magnificent physique, who retain the characteristics of youth until late in life. These people, he found, live on a frugal diet of goat's milk and vegetables.

Milk ranks high in digestibility. Its fat is 99 per cent digestible, its

* By November 1944 this ordinance was in effect throughout Nevada and Alaska as well as in 1,001 municipalities and 150 counties and districts in 36 other states and Canada with a total population of 26,142,664.

protein 97 per cent, and its carbohydrates 98 per cent. The fact that fat is present in emulsified form makes it more easily assimilated than most other food fats. Moreover, milk coagulates in the stomach, which is advantageous to the digestive process.[71] Research work now being carried on by the United States Bureau of Dairy Industry[73] indicates that there are other nutritive qualities in milk besides those generally attributed to it. Experimental animals have been fed a synthetic mixture of all the known nutrients of milk, while other animals were fed natural milk: the animals fed milk grew more and were in better general physical condition than those receiving synthetic milk. Bureau workers do not as yet know exactly what this factor is, but further research is continuing toward its identification.

On the other side of the ledger, milk has some defects. It is deficient in iron and copper and cannot be considered a very reliable source of vitamins C and D. Furthermore, experiments have shown that infants and young animals restricted entirely to milk over considerable periods of time develop anemia. Milk in the diet of certain individuals produces allergic symptoms: it was reported to be the contributing factor in 40 per cent of 120 cases of allergy studied.[20] Even with these limitations, the advantages of milk as an article of diet greatly outweigh the disadvantages, and it is still considered "Nature's most nearly perfect food."

THE HEALTH DEPARTMENT'S RESPONSIBILITY

The public health official has a very prominent part to play in the dairy industry, with a heavy responsibility to both the industry and the consumer. In the early history of milk control, inspection was primarily for the detection of adulteration and prevention of fraudulent practices. Today this aspect has largely disappeared, and the problem now is mainly one of education, leadership, and technical assistance. Dairymen and milk processors alike turn to the competent health official for advice and guidance, and it is through such mutual cooperation that benefit accrues to the whole community.

Acting jointly, the health department and the dairy industry can encourage the increased consumption of safe, wholesome milk and dairy products and engender public confidence. There is a challenging educational job to be done in this connection, for the consumer is not yet fully aware of the dietary value of dairy products. A recent

poll has disclosed that 43 per cent of adult Americans use no milk and 34 per cent no milk or cheese. If good nutrition is to be encouraged, Americans need to know more about milk and use it more generously. To this end, health officials must promote the increased use of pasteurized milk and dairy products by emphasizing their nutritive value and the value to the community of a well-supervised pasteurized supply. While significant advances have already been made, much remains to be done.

The control and regulation of milk is well recognized as an essential governmental function and has been so held in courts of law in all parts of this country, for milk, though of such great importance nutritionally, is a food which when produced and handled carelessly may easily become infected and serve as a ready vehicle for the transmission of disease. The expenditure of public funds to insure adequate and effective supervision of the milk supply is justified in terms of sickness prevention. The validity of such a statement can quite readily be demonstrated when one reviews reports of milk-borne outbreaks of disease. Records reveal that milk-borne disease is negligible, even non-existent, where well-organized milk control measures are in effect and where proper pasteurization is employed. In fact, proper pasteurization is much more likely to be practiced where vigilance is exercised on the part of control agencies. A review of records in New York City, for example, where no raw milk other than a relatively small amount of certified milk is sold, indicates that no recorded milk-borne outbreaks occurred in the twenty-two-year period 1917–1938, inclusive, while the state, exclusive of New York City, had 151 milk-borne outbreaks.[11] Situations comparable to this exist throughout the country, leading to the conclusion that the greatest need, generally, for raising sanitary standards in the production and handling of milk is in the smaller cities and towns and in rural areas where organized milk control is not well developed or is non-existent. A compilation of records of outbreaks attributable to milk and milk products as reported to the United States Public Health Service by State and Territorial Health Officers for the year 1941 reveals that more than 80 per cent of such outbreaks occurred in communities with populations of 30,000 or less.*

* Data arranged by the author from reports issued by the United States Public Health Service.

Population of community involved (1940 Census)	*Number of outbreaks reported*
Less than 5,000	18
5,000 to 15,000	6
15,000 to 30,000	6
Over 30,000	7

Moss[58] studied milk-borne outbreaks of disease occurring from 1908 to 1938, and found that about half the outbreaks and cases occurred in communities having a population of less than 1,000, about 38 per cent in communities having a population of 1,000 to 10,000, and 12 per cent in communities having a population over 10,000. Typhoid fever was the disease involved in the majority of outbreaks. Septic sore throat and scarlet fever, with equal percentages, were the next two most prevalent diseases. Although typhoid was responsible for most of the deaths, the streptococcic infections caused the greatest number of illnesses. About 95 per cent of the disease outbreaks resulted from the use of raw milk products.

Two of the most devastating milk-borne outbreaks within recent years were those in Montreal, Canada, in 1927, involving 5,002 typhoid cases and 533 deaths caused by a supposedly pasteurized milk supply, and in Lee, Massachusetts, in 1928, in which there were nearly 1,000 cases of septic sore throat and 48 deaths. These outbreaks illustrate tragic yet challenging conditions to which the milk industry and health officials alike must give their best thought and effort if other tragedies are to be averted. The epidemic at Lee deserves further amplification in that it is perhaps more typical of an outbreak due to infected raw milk than was the Montreal epidemic, where raw milk was by-passed around pasteurization equipment yet sold as pasteurized milk.

THE LEE EPIDEMIC[52]

Lee, with a 1928 population of about 4,000, is a residential, farming, and manufacturing community in the extreme western part of Massachusetts. During the first week in July 1928, physicians in this town were called in on so-called influenza cases; by July 6th, five hundred cases had developed. The Massachusetts Department of Public Health had three representatives in the town by the 7th, and

after investigation the epidemic was diagnosed as septic sore throat. Immediately the local board of health issued an order requiring all milk to be pasteurized or boiled, prohibited public gatherings, and closed restaurants at 8 P.M. Emergency services were set up through a central epidemic bureau. Eighteen doctors and 185 nurses were sent in from other communities and states.

Through investigation of the community's milk supply it was found that 85 per cent of the milk consumed was supplied by four distributors of raw milk. Distributor A supplied 35 per cent of the population; he did not produce his own milk, but obtained it from eight dairies. The milk was delivered in cans from these dairies and was poured into the upper trough of a tubular cooler; from the cooler the milk passed to a manually operated bottle-filler, with the capping done by hand. The bottled milk was placed in a wooden ice chest the size of which compelled high and close stacking, and the temperature could not be well controlled. The bottles were washed with a brush in a wooden sink. Some of the milk was sold in 8-quart cans. The cans were steamed by means of a hose line connected to a boiler, but the bottles were not sterilized.

Of the 640 to 700 quarts of milk processed daily at the plant of Distributor A, between 160 and 170 quarts were obtained from Dairy D. The morning milk of Dairy D was used for cream. The routine at the plant of Distributor A was to process a small supply from a tuberculin-tested herd first, the milk from Dairy D second, and then the milk from the remaining dairies. As the trough was cleaned only twice a day, it would seem possible for contaminated milk processed earlier to infect some of the milk flowing through the trough at a later period. A bacteriological examination of milk from all dairies supplying Distributor A revealed the presence of hemolytic streptococci (Beta type) in the milk of the Dairy D supply.

At Dairy D a cow was found with active mastitis of the left front quarter of the udder. Hemolytic streptococci of the epidemicus type were recovered from a sample of the milk from this cow. The cow had been added to the herd on April 27. There were two regular milkers at the dairy and five others who had milked occasionally between April 27 and July 8. The milking was done by hand. The udders of the cows were not cleaned before milking.

On April 16, Mr. Y entered the employ of Dairy D as a milker.

He was taken sick on May 29, but worked on that day and on May 31. On June 1 he was so ill that he had to remain in bed, and on June 4 he was sent to the hospital with a diagnosis of lobar pneumonia and acute pleurisy. He remained in the hospital until June 29. On June 2, two of Mr. Y's four children became sick with sore throats; they recovered on June 8. After each milking Mr. Y regularly took home two or three quarts of milk. The sickness in this family offers several possibilities. The Y family may have had the same infection that later became epidemic; they may have had a disease caused by an organism which of itself would be unable to produce septic sore throat but which after passing through the udder of the cow became so changed that it could give rise to the disease; or they may have had a disease which had no connection with the subsequent epidemic.

In his comprehensive study of the Lee epidemic, Lombard gives these facts in his summary:

1. There were between 925 and 975 cases and 48 known deaths in this epidemic of septic sore throat.
2. The epidemic was caused by the transmission, through raw milk, of hemolytic streptococci from the infected udder of a cow.
3. The method by which the cow was infected is unknown, although some evidence points toward a milk handler who was sick.
4. Among the regular users of the infected milk the attack rate was greater in females than in males, but it shows no significant differences in the various age groups.
5. The incubation period of the disease averaged two days.
6. Over 90 per cent of the cases occurred within a period of two weeks.
7. Contact probably was responsible for less than 5 per cent of the total cases, but it is impossible to establish this definitely.

Such a tragic example of the havoc wrought when milk becomes infected again emphasizes the responsibility faced by government, a responsibility which requires the employment of trained personnel, supported by adequate legislation to insure that milk will be properly handled and pasteurized. Disasters such as the one at Lee can and must be prevented. The total cost of such an epidemic can never be accurately estimated, but some facts of significance can be mentioned. An additional appropriation of $33,000 was made by the community to pay for special medical and nursing service—a tax rate increase of 30 per cent. In addition, large sums were paid by individuals for medical and nursing services and for funeral expenses;

time was lost from work, and business concerns in the community suffered losses which cannot be estimated.

As a further interesting commentary on the economic loss due to a milk-borne outbreak, Brooks[11] reports an investigation in a town of 4,742 persons in which there was an epidemic of 511 cases of scarlet fever, about one in nine of the population having been ill. With the cooperation of the secretary of the local chamber of commerce he was able to obtain some interesting data on the effect of such an outbreak on business in general. A canvass was made of two manufacturing plants and sixteen places of business: the estimated cost due to loss of business and the closing of one of the manufacturing plants was $147,721. Although the canvass did not include all business places or the cost to the families of victims of the epidemic, this figure is sufficiently impressive to convince the general public how important it is to make provision for adequate supervision of a community milk supply.

THE ECONOMIC IMPORTANCE OF MILK

Milk from the economic viewpoint occupies a very significant place in American agriculture. The cash income derived from its sale is larger than that of any other farm commodity including grain crops, and represents twice the cash return from cotton.[57] When it is realized that milk is produced on nearly five million farms from approximately twenty-six million cows and that it must be handled and processed in such a manner that it reaches the consumer in a salable and palatable form, the magnitude of the problem and the ramifications of the whole industry can readily be appreciated.

II

PLANNING AND ADMINISTERING A MILK CONTROL PROGRAM

ALTHOUGH the situation presented by the small community with no organized health service has shown gradual improvement in recent years with the creation of full-time county and district health departments, it is in these less densely populated areas that a milk sanitarian finds a real challenge when carrying out milk control work.* The suggestions in this chapter on objectives and procedures to be followed in relation to milk control are written mainly for the guidance of the sanitarian in such areas, but they are broadly applicable to all milk control activities everywhere.

OBJECTIVES OF MILK CONTROL

Before examining the actual planning and execution of procedures, it is well to consider the broad objectives of milk control. The first objective in every effective milk sanitation program is to promote the increased use of high-quality pasteurized milk; while there are secondary objectives which are closely interrelated, this one is foremost and basic. The safety of a community's milk supply is in direct proportion to the percentage of properly pasteurized milk consumed, and since the sanitarian must devote his energy to milk safety, proper pasteurization is the surest way of attaining it. Many ordinances requiring pasteurization of all milk have been enacted after a devastating milk-borne outbreak of disease has occurred, but no community wants such a disaster and no milk sanitarian can afford to wait till one strikes, to begin advocating pasteurization.

The second objective is to raise the sanitary quality of *all* milk sold in the area, that is, milk sold raw as well as milk intended for pasteurization. It is not possible to have good pasteurized milk if the supply for pasteurization is of inferior sanitary quality. Pasteurization must not be used as an excuse for making inferior milk

* Recent studies show that 31 per cent of this country's population reside in areas in which there is no access to full-time local public health service; less than 2,000 of the country's 3,100 counties have developed full-time health service.[59]

marketable. While the ultimate aim of the milk program is pasteurization of the entire milk supply, the sanitary quality of the raw milk sold at retail cannot be overlooked or neglected. One hundred per cent pasteurization may not be realized for a number of years after a milk program has started; in the interim the raw milk supply must be closely supervised. Careful inspection and supervision of such supply, with the raising of sanitary standards generally, fosters pasteurization. Raw milk dealers with a substantial sales volume will be quick to observe the increased emphasis being placed upon pasteurized milk, and will, as has frequently happened, install pasteurizing equipment. Certain dealers, however, will continue to sell raw milk until they are required to pasteurize, so that during this transitory period the sanitarian should work continuously toward a Grade A raw milk supply meeting the standards for that grade recommended by the United States Public Health Service or standards of comparable merit. In other words, if raw milk is to be sold it should be surrounded with all possible sanitary safeguards.

Finally, the sanitarian should adopt as an objective a policy that will build public confidence in the milk supply and increase the use of milk in the diet. Much of the work done by sanitarians goes unnoticed, since the average citizen takes relatively little interest in milk control and is, in fact, rather apathetic toward the whole subject unless the milk he buys has dirt or some other foreign substance in it, sours easily, or has an "off" flavor. A great deal of publicity about milk has been adverse in nature, particularly when milk is indicted as the cause of a disease outbreak. After the sanitarian has developed his program to a point where he has evidence to show definite improvement, he should publicly announce such fact. (Means of accomplishing this will be mentioned later in the chapter.)

FIRST STEPS IN BUILDING A PROGRAM

With the inauguration of any new community program, sufficient study, inquiry, and thought must be given to local conditions so that pertinent facts can be gathered and administrative blunders avoided. While the best manner of approach may vary from one locality to another, a careful and detailed survey of the general milk situation serves as an excellent starting point for program development. Before any field work is begun, however, the sanitarian should take into con-

sideration three factors which necessarily affect the opinions and attitudes of local residents: first, the newness of the program; second, the accessibility and frequency of the new service (service may previously have been rendered only on a thinly distributed state-wide basis); and third, community understanding of the significance of the service. When these principles are taken into account, it is apparent that well-laid plans must be made and then followed as closely as possible. One of the most logical approaches is through a survey of the situation. Initiating a program on this basis, which actually means the collection, correlation, and utilization of basic facts, gives the sanitarian first-hand information which will prove of inestimable value in planning a course of action.

Fact-finding survey

In some unorganized areas milk inspection will have been done by part-time inspectors holding other public office or engaged in other activities; they may have served well within their capabilities, and although their work may appear inadequate it should not be put aside too lightly. Initial visits to dairies and milk plants may be arranged with such local persons as one means of becoming acquainted with those in the milk business. Milk dealers obviously will be interested to know what changes they may expect in their business as a result of the organization of a full-time health service. If the sanitarian visits dealers in company with a former inspector, a certain confidence may be engendered which will demonstrate that the local situation is being considered. This does not imply a willingness on the part of the sanitarian to follow precedents of a previous program, but it will show that new duties are being delegated in an orderly, amicable fashion, and that the sanitarian is attempting to study and acquaint himself with local problems. It is folly to expect immediate perfection, and a program predicated on that assumption will inevitably cause disruption and be a failure.

In his fact-finding survey the sanitarian should contact as many sources of information within his area as possible. Generally, local citizens have an interest in and an appreciation of their community problems, and facts gained in this manner may be of value. It is suggested that the following representative groups and persons be interviewed:

1. The medical profession. One or more officers of the county or district medical association should be visited. Such a visit should be arranged through the health officer. The status of the local milk supply should be discussed. Possibly it will be found that certain members of the profession are advocates of raw milk, a fact of considerable importance in relation to a milk program.
2. Veterinarians. Veterinarians work among farmers and their opinions are respected in the community. The sanitarian and the veterinarians must work closely in the control of such diseases as contagious abortion and mastitis among dairy cattle.
3. The county agricultural agent. The county agent's knowledge of the area's agricultural assets and of the local dairy industry will be valuable. He can assist in promoting the milk program, particularly among milk producers, when he understands what its objectives are. Excellent relationships generally exist between the county agent and the health department.
4. Public school authorities. The superintendent of schools, for example, should be asked to express his opinion of the quality of milk served school children. The accessibility of pasteurized supplies to serve schools in rural areas may be discussed.
5. Governing bodies. This includes members of district and township boards of health, members of the county government, and other public officials.

The above-mentioned procedure is suggested, but it may be assumed that sufficiently complete data can be obtained in a less arduous manner from state agencies. Data from such sources will undoubtedly be available and most certainly should be used to supplement local information. For example, results of recent laboratory examinations of milk or dairy products, inspection reports, orders for improvements or changes, and records of court action past or pending should all be available to the local health department through whatever state agencies may be involved. In any event, by following this proposed plan the sanitarian will make valuable local contacts with persons and agencies, and they in turn with him. These are some of the people with whom he must work; in fact, he may solicit their support at a later date when a new milk ordinance or other reforms in milk control are being initiated. The sanitarian who engenders confidence and sells himself on sincerity of purpose will win the respect of local citizens; his success in that alone will be a measure of his effectiveness in the community. This type of fact finding, which in reality simply means tapping community resources, is but the first step in the development

of the program. Facts that are valid can be used for future planning and erroneous conclusions can be discarded.

Survey of milk plants

Up to this point the sanitarian should have gained a general impression of conditions relative to the milk supply in his area, and should now be ready to begin a rather detailed survey of receiving stations and milk plants. In this connection he may use as a guide state laws or regulations, the latter in many cases being modeled after the United States Public Health Service recommended milk ordinance. Through such a survey at least two purposes will be accomplished: first, determination of how well milk plants comply with acceptable standards and what improvements are needed; second, compilation of records which later will be valuable for purposes of comparison when improvements in milk sanitation have been brought about. This survey may be made on a standard plant inspection form, but it is recommended that for the purpose of an initial study a more flexible form be used which allows sufficient space for written comments and other explanatory notes. The form must be sufficiently detailed to cover all major points of sanitary interest. Such a survey sheet should include such items as the following: general condition and upkeep of plant; kind, size, and condition of equipment; general attitude of employees and management; capacity of plant; the names and addresses of milk haulers trucking milk to the plant; the names and locations of all milk producers selling to the plant; and so on. In the author's experience, detailed information of this type frequently serves as an excellent source of reference, although the fact at the moment may seem relatively unimportant. A sample survey sheet in *condensed* form is illustrated below as a suggested guide. Additions or deletions may be made to suit the specific needs of the individual or the situation.

______________Department of Health

Milk Plant Survey Record

1. Name of plant. 2. Location. 3. Mailing address. 4. Name of owner. 5. Name of manager. 6. Number of routes. Number of employees. 7. Dairy products other than milk handled. 8. Approximate daily sales of milk in quarts or gallons. 9. Brands of milk sold: Homogenized, Vit. D, Jersey, Grade A., etc.

10. Age of business. 11. Years at this location. 12. Number of milk haulers. 13. Names of milk haulers. 14. Number of producers selling to plant (also list of producers' names and locations). 15. Type of vehicle used by haulers: insulated or open trucks. 16. Number and names of farmers hauling own milk. 17. Is inspected and uninspected milk hauled on same trucks? 18. Type of retail delivery vehicle. 19. Type and condition of plant. 20. Building layout, size (make rough sketch showing floor plan). 21. Interior construction—describe: include walls, ceiling, floors, drainage, windows, ventilation, screening, provision for separate processing rooms, storage space, etc. 22. Equipment—give number, make, capacity, type, general condition and cleanliness of such pieces as: weigh and dump tanks, pasteurizing vats, cooler, bottler, bottle-washer, can-washer, homogenizer, clarifier, etc. 23. Thermometers—give number of recording and indicating thermometers; make accuracy test with approved inspector's thermometer. 24. Toilet and hand-washing facilities—describe and note location, adequacy, and maintenance. 25. Water supply—if well is used, obtain data such as type, depth, location, construction, capacity, protection, and whether inter-connected with another supply. (A water sample may be collected.) 26. Refrigeration facilities—size, condition, cleanliness, temperature of cold storage room, and means of refrigerating milk on delivery vehicles. 27. Employees—note apparent knowledge of duties, personal appearance, type of work clothes, personal habits. (Later a health history may be taken on each employee.) 28. Cleaning facilities—note cleaners used, brushes, pipe-washing troughs, and observe cleaning methods employed. 29. Attitude and intent—note awareness on part of both personnel and management in connection with plant sanitation. Note attitude of management and apparent willingness to accept suggestions. 30. Remarks and additional comments.

Date ____________________ Inspected by ___________________________

A survey of this nature should be made with considerable care, allowing sufficient time to carefully note general plant conditions and practices. Inspections which are made later will be of a more specific and remedial type, whereas this initial survey may be considered primarily as a means of recording existing conditions. Conclusions drawn from such a survey may serve as a basis for planning long-term improvements, educational procedures, and ordinance revisions.

Collection of milk samples

After completion of the plant survey, the sanitarian may wish to ascertain the sanitary quality of the bottled milk sold. This, obviously, requires the collection of representative samples for labora-

tory examination, and so far as possible these should be collected from delivery vehicles. This procedure assumes that laboratory facilities are available, either locally or through a central or branch state laboratory. It is difficult to operate an effective milk control program without laboratory facilities, and while it is realized that these do not exist to the fullest degree in some localities, arrangements for laboratory service can generally be made. As complete an examination as is reasonable should be made to give accurate knowledge of the quality of the product sold and to serve as a basis for judging the supply. (Laboratory procedures used to evaluate milk are discussed in Chapter IX.) It is recommended that the following tests be made: 1) butterfat and total solids determination, 2) standard plate count or direct microscopic examination, 3) phosphatase test for pasteurized milk, and 4) sediment test. A coliform test may be added, but not necessarily at the outset. If laboratory facilities are reasonably accessible, a series of samples should be collected within a relatively short space of time—fifteen to thirty days is recommended. One cannot draw conclusions from an examination of a single sample; a series of three to five samples taken at different intervals will give a more representative picture of the supply. However, the sanitarian must bear in mind that he is still accumulating facts about the sanitary condition of milk in the area and that it is only reasonable to suppose that certain samples will show unsatisfactory results when judged by acceptable and recognized standards. He should appreciate that immediate correction is not always possible and that the significance of results must be fully understood before he can adequately interpret them to the milk plant operator in terms of probable cause so that remedial steps can be taken. It is important to stress again the fact that such laboratory results as may be obtained from sampling are mainly for purposes of survey information. The indiscriminate sampling of milk in the early development of a milk program is not indicated. It is much more important to concentrate first on correction of physical and processing defects in plants and to encourage better production methods on farms than to put into practice a sampling routine. If production and processing are obviously below acceptable minimum standards, an effort is first needed to raise them, with milk sampling used later as a check upon improvements which have been incorporated.

SURVEY OF PRODUCING FARMS

After preliminary samples from milk processors and retailers have been examined and the results are available, the next step is to visit farms where the milk is produced. The sanitarian is empowered to do this either through authority delegated to him by state law or as a duly authorized representative of the local, county, or district health department. These initial farm visits are very important. In an area where little if any dairy farm sanitation has been done, one cannot always expect a too cordial reception. There will be considerable explaining to do in connection with the milk control program and the reasons for farm inspection. Diplomacy and good judgment are needed. The sanitarian who approaches a farmer with the proverbial "chip on his shoulder" will find that such an attitude does not cultivate amicable relations.

The first objective of a farm visit of this type is to become acquainted with the milk producer and with his problems. Most producers will be receptive to the man who can sell them on the value and need for sanitary production methods. Educational methods and salesmanship should be utilized. Later, as the program progresses, ample means are available for dealing with the uncooperative, recalcitrant individual, but it is certainly not advisable to begin disciplinary or legal action against any producer until a program is well established and all other educational and persuasive measures have been tried. These initial visits to producers must be quite carefully handled; in fact, it is recommended that no formal grading of the premises be undertaken at this time. However, careful observation can be made and mental note taken of the general situation. The producer should be told that samples of his milk will be examined at periodic intervals and that follow-up visits will be made in an effort to improve production methods and milk quality. Mention should be made of the fact that all producers whose premises, equipment, or methods do not meet minimum standards will be expected to make certain improvements over a period of time. The point should be made that periodic supervision is planned and that an inspection report on equipment and methods will form a part of the work as the program progresses. A frank discussion with the dairyman about authority for local control and the need for sanitary methods is one of the most necessary and constructive types of groundwork when inaugurating a new

program. Obviously, principles of good personal and public relations should be kept in mind.

PROCEDURES TO ADVANCE THE PROGRAM

Thus far in this chapter emphasis has been placed upon a logical approach to milk sanitation based primarily upon a careful survey of the milk supply. It is not uncommon for a sanitarian to work for a considerable period of time without the advantage of a modern milk ordinance. State laws are usually general in character, or the standards that must be used may be in the form of regulations promulgated by the state department of health, which may not have the force of law. An effective milk ordinance enacted by local legislative authority is another objective toward which the sanitarian should work. While he may not be able to obtain enactment applying to his entire area, he should sponsor and promote an effective ordinance in the larger cities and towns or, if possible, on a county-wide basis.

How best to bring about this objective is sometimes a perplexing question. However, the first step to be taken is definite: local authorities who have the power to act must be fully informed concerning the local milk supply; they should be given all the facts revealed by the initial survey and kept informed of any subsequent changes. When the health officer and the sanitarian agree that a favorable time has come, they should ask for an opportunity to meet the city or town council and propose that consideration be given to the enactment of a modern milk ordinance. Time is given, of course, for all members of the council to acquaint themselves with its provisions. The council may wish to hold a public hearing on the matter, at which time the health officer and sanitarian, along with other interested parties, will present their case. Thorough preparation should be made for such a hearing, with all provisions of the ordinance and its interpretation well in mind. Opponents' arguments should be given careful consideration and answered on an impartial and scientific basis. The council may then take the matter under advisement, usually asking for a legal opinion from the city or village attorney.

From this point on, one of several events may happen: first, the ordinance may be accepted as originally presented, and after the prerequisite number of readings it may be enacted; second, some changes may be made, and if these are minor they should generally be ac-

cepted; third, the ordinance may be indefinitely postponed and no further action taken. When an ordinance is passed, the date when it is to go into effect is set; this is usually several months hence, to allow those affected to make necessary changes and improvements to comply with its provisions. If a thorough preparation has been made by the sanitarian and health officer and they present convincing and clear-cut arguments for enactment, the probability that the ordinance will be adopted is good in the majority of cases. Obviously, situations sometimes exist when good arguments and the best-laid plans do not result in favorable action by the law-making body, but such an event, though discouraging, must not be a deterrent to the objective of a safe milk supply. Promotional and educational work can go forward even though needed legislation is lacking.

Community education

Educational activities in milk control offer the sanitarian unlimited possibilities. Many a successful milk program has had as its foundation a sound educational approach. In contrast, abrupt enactment of rigid requirements without sufficient understanding on the part of milk producers and dealers and the public has led to ill will and confusion.

Earlier in this chapter it was pointed out that the basic objective of a milk program is the increased use of properly pasteurized milk. To foster this objective the following educational procedures and policies are suggested:

1. Publicly and vigorously advocate the pasteurization of the community's milk supply.
   a. Be certain that all members of the health department staff fully understand the importance of pasteurization and that they, too, advocate the use of pasteurized milk.
   b. Recommend, in writing, the use of pasteurized milk to schools, hospitals, and similar public institutions using raw milk.
   c. Fully explain to all raw milk dealers your position and your reasons for advocating milk pasteurization.
   d. Advise and encourage raw milk dealers to install pasteurizing equipment, or urge that their milk be processed at some local pasteurization plant. Take raw milk dealers on visits to local pasteurizing plants.
2. Use every reasonable device to stimulate community interest in pasteurized milk. Discuss, explain, and advocate pasteurization through

the press, before clubs and civic organizations, at schools, and through similar channels within the community.

3. Advocate the passage of an ordinance requiring the pasteurization of all milk, explaining the need for such an ordinance and how the public will benefit through reasonable legal safeguards.

The utilization of such a plan for improving the milk supply is admittedly one which requires courage, hard work, and a willingness to accept the challenge of difficulty and discouragement. The milk sanitarian who adopts a "laissez faire" attitude will do little toward bringing about pasteurization. A firm stand is necessary on this issue, and every reasonable effort must be directed toward it.

Instruction of Dairymen and Milk Plant Employees

Remarkable progress can be made toward improving the quality of milk when dairymen and milk plant employees are given instruction in milk sanitation. When the public health reasons for milk ordinance requirements are explained, many misunderstandings can be overcome and a better working relationship developed between the sanitarian and those engaged in the milk business. Usually, separate meetings are arranged for milk producers and for pasteurizing plant employees.

In the case of the milk producer, emphasis is placed upon dairy farm sanitation and the importance of certain prescribed procedures so that the milk will be of good quality not only for marketing but for use by the farm family. This aspect would probably include a discussion of such diseases of cattle as brucellosis and mastitis, as well as demonstrations of procedures for cleaning milking machines and so on. Use should be made of appropriate motion pictures and slides. The milk hauler should be invited to be present at such meetings.

One of the outstanding pieces of work in this connection has been carried on by the City of Baltimore, Maryland, among shippers on its milk shed. This program was begun in 1932, with health department field men conducting actual demonstrations of milking-time procedures right on the farm under actual conditions. A group of ten producers was invited to each demonstration, and during the first year 90 per cent of the city's 4,000 producers voluntarily attended. Furthermore, producers whose milk did not come up to health department standards were required to attend a warning demonstra-

tion, at which rules of good milk production were again reviewed. Subsequent failure to ship satisfactory milk, or rejection of milk because of poor quality, resulted in a so-called "proof demonstration," at which the producer had to conduct his own demonstration, in the presence of the field man, to show that procedures would be properly carried out. To supplement the demonstration the Baltimore Health Department issued a manual illustrating and describing in detail milking and handling procedures as well as essential equipment required.[33]

Instruction of milk plant operators and employees is especially remunerative in connection with good plant operating methods. In a sense, a properly arranged course for this group can be considered vocational training. Besides the several features of milk plant operation directly concerned with sanitation and safeguards to the milk supply, other subjects may be included, such as machinery and truck maintenance, salesmanship, and the manufacture of dairy products. Outside speakers who are specialists in their fields should be invited to participate. Programs of this type have proved successful in Lansing, Michigan, Oakland, California, and Illinois (see Chapter VIII).

FREQUENCY OF INSPECTIONS AND SAMPLING

In county and district health departments the sanitarian will have many duties to perform other than those relating directly to milk control. How frequently inspections can be made and samples collected will depend upon how much time can be allocated within the field of general environmental sanitation for milk work. It would be illogical, for example, to devote major attention to milk sold in the county from a large city plant which is under capable supervision by a city health department, and neglect some other important and acute phase of sanitation. However, public health administrators have established guides to follow in this connection which appear to assure a reasonably adequate service. The entire program in sanitation on a local level has recently been reviewed by a committee of sanitary engineers,[3] and the following *minimum* standards in relation to milk are recommended for service rendered on an annual basis:

Inspection of retail raw dairy farms—6 inspections per farm
Inspection of plant-producer farms—2 inspections per farm
Inspection of pasteurization plants—12 inspections per plant

This committee has also recommended frequency of milk sample collections, setting these standards as minimum, again on an annual basis:

Retail raw milk supplies—8 samples per farm
Plant-producer supplies—8 samples per farm
Pasteurized milk supplies—8 samples per plant

These recommendations should be viewed mainly as a guide, since conditions may vary from one locality to another and more intensive work may need to be done as an active milk control program develops.

RECORD-KEEPING

An efficient record system is a prerequisite to a well-organized and effective milk program. Just as a business establishment must keep records of its transactions, so the alert sanitarian must develop and keep accurate records of his work. Many good record systems have been devised, and it is not the purpose here to recommend one system as being superior to another; however, the facts which must be recorded are, within reasonable limits, somewhat standard for milk inspection practice in this country.

There must be on file in the health department the name, address, and location of every receiving station, pasteurizing plant, retail raw milk dairy, and plant producer whose product is sold in the area under the jurisdiction of the health department. These records should include the date and result of each inspection or investigation, the date milk samples were collected and the result, the dates when any producer was excluded, with ample space left on the form under "Remarks" to record any significant or unusual occurrence, changes and improvements made, court action taken, change of ownership, and so on. The United States Public Health Service has developed ledger-type record sheets which admirably fulfill the above requirements. Those listed below can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C.

Producer-Distributor Inspection Record (loose-leaf ledger form for posting producer-distributor dairy inspection and laboratory results)—Form 8976–B

Pasteurization Plant Inspection Record (loose-leaf ledger form for posting pasteurization plant inspection and laboratory results)—Form 8976–C

Plant-Producer Inspection Record (loose-leaf ledger form for posting plant-producer dairy inspection and laboratory results)—Form 8976–E

Adequate, accurate records are of immeasurable value to the sanitarian, for a number of reasons:

1. They show the amount of work done—the sanitarian must account for his time and make reports to his superiors; also, records must be available when an appraisal of a milk program is made, for they show weaknesses as well as strengths and where adjustment may be needed to give the program balance.
2. They measure progress—the record of one year compared with that of another points to progress or to a lack of it.
3. They form the basis for changes—revision of standards or ordinance requirements is often indicated from a study of records.
4. They serve as evidence if legal action has to be taken—testimony is always strengthened when date, time, and place of violations or other infractions are accurately recorded.

Logical planning, the use of community resources and educational methods, and a good system of record-keeping are all necessary to a well-rounded milk control program. Periodically the milk program should be re-examined and an attempt made to correct weaknesses and institute procedures which will pay the best dividends in terms of milk safety. The sanitarian should enlist the services of federal and state milk control specialists in appraising his program. A safe milk supply is a community asset worthy of attainment.

III

ESSENTIALS OF SANITARY MILK PRODUCTION

THE foundation of a safe milk supply begins with sanitary production methods on the farm. Every reasonable precaution must be taken by the milk producer to exclude infectious matter and contamination from the supply. Essentials involved in the production of clean milk are now well recognized and may be listed as follows:

1. Health, cleanliness, and good personal habits of the milk handler;
2. Healthy cattle, clean at the time of milking;
3. An approved dairy water supply;
4. Sanitary facilities for the disposal of excreta;
5. A sanitary environment of the dairy premises;
6. A well-constructed milk house with approved facilities for handling milk, washing and storing milk utensils, and cooling and holding milk;
7. A stable or milking barn so constructed that it can be maintained in a sanitary condition.

Although it may be possible in certain isolated instances to produce milk of low bacterial content with meager equipment and without meeting certain of these requirements, it is highly improbable, and the milk sanitarian must be prepared to deal with each of the above conditions singly and collectively since all have a definite bearing on the sanitary quality of milk. The problems involving milk production generally revolve about these seven essentials. In the following pages, each of the seven points is discussed to show its importance and relationship to sanitary methods of milk production.

THE MILK HANDLER

Outbreaks of disease traced to infected milk frequently indict the milk handler, because of his illness or his carelessness or both.

One of the first principles of good milk production is that the milker's hands be clean. Hands soiled with discharges of bowel and bladder may infect milk with disease organisms, particularly those causing typhoid fever, paratyphoid fever, and bacillary dysentery. Irrespective of whether the milk is to be sold raw or is intended for

pasteurization, such infectious matter must not gain access to milk. In addition, hands soiled with discharges from the mouth and nose present a potential hazard in relation to such diseases as scarlet fever, septic sore throat, and diphtheria. It is interesting to note the emphasis placed on hand cleanliness in dairies that produce certified milk under the supervision of the American Association of Medical Milk Commissions, Inc. Quoted herewith is a regulation taken from the *Employees Manual* issued by the Biltmore Dairy Farms, of Biltmore, North Carolina:

> The hands of all employees handling dairy products shall be immaculately clean and sterile at all times. Nails must be constantly clean and carefully manicured. No employee handling dairy products shall ever go on duty without washing his or her hands carefully and thoroughly with warm water, liquid soap and scrubbing brush, and thereafter sterilizing them with chlorine solution (which will be provided at all wash stands) before dairy products are handled. If the hands come in contact with the hair, face, or any part of the body, or any substance which might cause contamination, the employee must immediately desist from handling any dairy product until his or her hands have been carefully washed with soap and warm water and sterilized with chlorine solution. Hands must be carefully dried on a clean towel after washing and before handling any milk products or containers of milk products and before milking. Moistening the hands before milking is prohibited. THIS IS OF UTMOST IMPORTANCE AND AN INFRACTION OF THIS RULE CAN NOT BE TOLERATED.[8]

On the average dairy farm, a simple yet effective expedient for encouraging milk handlers to wash their hands is to provide an ordinary wash basin, soap, and clean towels (paper towels are recommended) in the milk house and in the milking barn. Furthermore, to remind milkers of the importance of clean hands, a sign should be posted requiring that the hands be carefully washed before milking or handling utensils. A sign such as the following is suggested:

CLEAN HANDS FOR CLEAN MILK

WASH YOUR HANDS BEFORE

MILKING OR BEFORE HANDLING UTENSILS

____________Department of Health

The clothing worn by milk handlers is likewise important, since hands and clean utensils come in contact with it. Because clothing

worn for general farm work readily becomes soiled, milkers should have a separate suit of clean overalls for milking or should wear clean washable aprons during the milk-handling period. Hand cleanliness and clean clothing are fundamental in the production of safe milk, and considerable emphasis should be placed upon this requirement. Promiscuous spitting around the dairy premises or the use of tobacco while milk is being handled should of course be prohibited.

THE CATTLE

The health of the dairy cow is essential to the safety and quality of milk. Diseased animals are an economic liability to the farmer and a hazard to the milk supply. The more common diseases of dairy cattle which are of significance from the standpoint of milk safety are bovine tuberculosis, contagious abortion (also called Bang's disease), and infectious mastitis (commonly known as garget).

Bovine tuberculosis

Bovine tuberculosis formerly ranked as a serious source of infection to milk, but in the last decade this hazard has been practically eliminated. The report of the Chief of the Bureau of Animal Industry for the year ending June 30, 1944, showed that of 8,894,466 cattle tested in the United States, Puerto Rico, and the Virgin Islands, two-tenths of one per cent were found infected and were removed from herds.[82] The program for the eradication of tuberculosis among cattle in the United States was begun in 1917, and from that year to 1944, inclusive, 3,872,416 tuberculous animals were removed from cattle herds in the United States and possessions. Every county and every state in the United States is now a Modified Accredited Area, signifying that the number of reactors within a given area is less than five-tenths of one per cent. Such an area is considered to be practically free of tuberculosis for a three-year period, at the end of which time it must be retested to prevent recurrence of the disease. It is significant to note that tuberculosis of bovine origin—glandular, bone, and abdominal—decreased 76 per cent from 1917 to 1936 when tuberculin-testing of cattle became widespread. According to A. C. Ragsdale, of the University of Missouri, the eradication program for cattle proved more effective than any method devised by medical

science for controlling tuberculosis of human origin.[67] Although tuberculosis infection in cattle has been reduced to a minimum, the milk sanitarian should check carefully with herd owners to make sure that necessary precautions are taken so that an occasional positive animal is not admitted to or is not present in a herd. This is especially important when milk is sold raw. Therefore, to be accredited a herd of animals must be found free of tuberculosis on two successive annual tuberculin tests or on three successive semi-annual tuberculin tests and physical examinations, and the herd owner must also comply with regulations relative to the maintenance of sanitary conditions and the admission of new cattle to his herd.

Bovine infectious abortion, or Bang's disease

Bovine infectious abortion is a disease of cattle variously known as brucellosis of cattle, Bang's disease, infectious abortion, or contagious abortion. Since "abortion" means the birth or expulsion of an immature fetus, this is one of the most prominent symptoms of this complex disease.[26]

Bang's disease in cattle is caused by a very small, short, oval-shaped microorganism. The organism, now called *Brucella abortus*, was first described as the cause of contagious abortion in cattle by Professor Bernhard Bang of Denmark. It may be found in the udder, the pregnant uterus, or in the discharges from the vagina of cows a short time (usually two or three weeks) after aborting or giving birth to a full-term calf. During this period a cow is especially dangerous as a spreader of disease to other cows. The abortion bacteria are found in the milk and the udders of cows that have aborted and sometimes in the milk of those that have not aborted. Many cows become permanent carriers of the *Brucella* organism and shed it continually in their milk. The organism may be found also in the bodies of aborted fetuses and full-term calves. In pastures or barnyards the organism is killed in four to five hours when exposed to direct sunlight. When protected from the air and the effects of drying and sunlight, as in manure, it will live for many days. A 2.5 per cent solution of cresol will destroy the organism in fifteen minutes, as will heating for fifteen minutes at 60° C. (140° F.).[26]

Other animals are subject to this infection. In swine the causative organism is *Brucella suis*, and in goats and sheep *Brucella melitensis*.

The fact that this disease is not always confined to cattle adds to its significance in relation to dairy and farm sanitation.

The milk sanitarian's interest in Bang's disease is twofold: first, to reduce the danger to persons consuming raw milk and other dairy products from infected cows; and second, to prevent the spread of the infection from one herd to another. The economic loss to dairymen through lowered milk production and loss of calves is likewise significant. The *Brucella* organism is the cause of the disease brucellosis in man, also known as undulant fever. The number of cases of human infection diagnosed recently indicates that it is more common than ordinarily realized: during 1931–1941 there were reported in the forty-eight states of this country 25,594 cases of brucellosis.[43] All cases are not attributable to the consumption of raw milk and dairy products, since persons working in packing plants, slaughterhouses, and similar establishments are frequently exposed, particularly to the porcine strain. Veterinarians and farmers, because of their work with livestock, are likewise frequently infected.

An outbreak of 77 milk-borne cases of undulant fever occurring in a small Iowa town was investigated in detail in 1941 by members of the Iowa State Department of Health. In this study it was found that four dairies in the town sold raw milk and that all the patients were served regularly or intermittently by one dairy. On being tested for Bang's disease, 3 of the 43 cows owned by this dairy were found to be reactors; also, half of the 24 hogs running in the cow yard were infected.[45] From this it seems necessary to conclude that pasteurization of dairy products and eradication of the disease among cattle and swine are the most important factors in the control of the disease.

As a part of his program in milk control, the sanitarian should be acquainted with the work carried on by the Federal Government in cooperation with the livestock sanitary board of his state, so that he can encourage and advise milk producers to have their herds tested for Bang's disease.* The present state and federal program is on an entirely voluntary basis, but the owners of reacting cattle slaughtered receive a state and federal indemnity in all states except California, Colorado, Indiana, Massachusetts, Nevada, Oklahoma, Texas, and Utah, where as late as 1944 no provision was made for state payment.

* All milk sold raw should of course come from disease-free herds.

In 1944, agglutination blood tests were given to 386,266 herds, representing 5,235,912 cattle; of the total number of cattle tested, 226,079 (or 4.3 per cent) were reactors. In the case of brucellosis in cattle, in order to be designated as modified accredited an area must have not more than one per cent of the number of cattle reacting to the last completed test, and not more than five per cent of the total number of herds infected.[82]

When a farmer wishes to apply for federal and state aid in the testing of his cattle for Bang's disease, he enters into an agreement with the agencies concerned. Application is filed through the State Bureau of Animal Industry or through the district office of the federal bureau. The following agreement form used for this purpose is shown mainly to indicate certain provisions which must be carried out by the livestock owner.

To the State Department of Agriculture of ________ through its Bureau of Animal Industry cooperating with the United States Bureau of Animal Industry, for control and eradication of Bang's disease:

In consideration of cooperative state-federal supervision with test of my cattle and other assistance to establish and maintain a Bang's disease-free herd, I, the owner signing hereunder, agree:

1. To submit my entire herd of cattle or such animal or animals thereof for examination and test or retest for brucellosis (Bang's disease) when requested or directed by the cooperating state and federal bureaus herein referred to, it being understood that said examination and test or retest shall be applied by a veterinarian assigned or authorized by the aforementioned cooperating bureaus.
2. To make a true statement complete in detail as may be requested at the commencement of any test or retest as to cattle added to my herd, and also of any treatment or use on or into any cattle of my herd of abortion vaccine, abortion bacteria or any preparation from or through the agency of Brucella microorganisms.
3. To dispose by slaughter under state or federal inspection all cattle declared or classified by said tests to be reactors unless otherwise prescribed through order or direction by the State Department of Agriculture from its Bureau of Animal Industry.
4. To limit cattle added to my herd over six months of age:
   a. To animals direct from herds officially certified to be free from Bang's disease, or
   b. To animals moved directly from herds located in Bang's disease accredited areas which showed all cattle negative to the last official herd test, but when such cattle are to be added to herds ac-

credited or in the process of accreditation, said animals must be held in quarantine for 60 days, and then pass a negative blood test before being added, or

c. To animals which have passed a negative official test for Bang's disease immediately when brought to my premises, held in quarters separate and apart from my herd for a period of 60 days, and finally have passed a second negative test before being made a part of the herd.

5. To handle and control my herd and all cattle thereof in full compliance with laws of the state and with rules and regulations of the state and federal departments relating to Bang's disease, which laws, rules and regulations are and shall be a part of this agreement.

IT IS TO BE UNDERSTOOD THAT WHERE INDEMNITY OF CATTLE CLASSIFIED AS REACTORS IS PROVIDED, THIS MAY NOT BE ALLOWED WHEN CATTLE ARE ADDED TO MY HERD CONTRARY TO THE PROVISIONS OF THIS MEMORANDUM OR IF OTHER VIOLATION OF SAID PROVISIONS BY ME OCCUR.

In witness whereof, I have signed this agreement this ______ day of ____________________, 194___.

Approved: State ______________ Signature ______________________

P. O. Address ______________________

Prevention and control of Bang's disease. As in the prevention and control of any communicable disease, certain well-established rules of management and sanitation must be practiced. Simply testing herds and removing reactors is not the whole solution of the problem by any means, and other pertinent regulations must be followed. The regulations listed below are from the Bureau of Animal Industry of the Michigan Department of Agriculture:

1. All animals in the herd should be blood-tested to determine whether they are infected with Bang's disease.
2. All reactors to the test should be sold for immediate slaughter or isolated from the rest of the herd as they are potential spreaders of the disease.
3. A retest should be made of the herd not more than 30 to 60 days later. If new reactors are found, they should be disposed of as stated above. Testing should be continued, preferably at 30 to 90 day intervals, until the herd has passed three entirely negative tests. These three negative tests should be at least three months apart. A single negative test is not conclusive proof of the absence of Bang's disease.

4. Additions made to the herd should be from herds tested and known to be free from Bang's disease. Negative animals from infected herds may be added but must be kept in quarantine for at least 60 days. If the animal is pregnant, she must be kept in quarantine for at least 20 days after calving. These animals, at the end of the quarantine period, should not be added to the herd unless their blood test is negative.
5. After each test and when the reacting animals have been marked for slaughter, the premises should be cleaned and disinfected.
6. All females should be isolated at the time of calving or aborting. The afterbirth and aborted calf should be destroyed by burning or proper burial. These animals should be separated from the rest of the herd for two or three weeks or at least until all vaginal discharges cease. If the cow aborts, she should pass a negative test before she is returned to the herd. Although most abortions are due to Bang's disease, it is well to remember that ALL ANIMALS THAT ABORT DO NOT HAVE BANG'S DISEASE, ALSO THAT ALL ANIMALS HAVING A POSITIVE REACTION TO THE TEST DO NOT ABORT.
7. If calves born from reactor mothers are to be used as additions to the negative herd, they should be isolated for two or three weeks after their last feeding from the dam. Then they should be fed milk from negative animals and should also pass a negative blood test before they are added to the negative herd.
8. Vaccines for the control of this disease are still in the experimental stage.*
9. All milk and milk products used in negative herds should be from Bang-free cattle or should be pasteurized. Milk from positive animals is a dangerous source of spread of the disease.
10. Bulls in Bang-free herds should be used for service only on cattle that have been tested and found free from Bang's disease.[56]

These control practices should be kept in mind by the sanitarian when discussing Bang's disease eradication. Frequently the dairyman is somewhat confused concerning his responsibilities and obligations, and a clarification of these will often encourage him to have the testing done.

Infectious mastitis

Infectious mastitis, commonly called garget, is a disease characterized by inflammation of the cow's udder. Streptococci are the

* Author's note: The Chief of the United States Bureau of Animal Industry reports that since December 1940 calfhood vaccination has been used as an adjunct to regular control and about 34 states have incorporated the vaccination of calves under supervision into their Bang's disease program.

causative agents in 98 to 99 per cent of the cases; injuries, chilling, and bruising of udders and teats have been responsible for isolated cases. The Staphylococcus, Brucella, Pseudomonas, and coliform organisms may account for mastitis, although these organisms do not cause it in more than one to two per cent of the cases. The organism most frequently causing the disease is *Streptococcus agalactiae*. Breed[9] has tabulated microorganisms that produce inflammations of the bovine udder (see Table I).

Streptococcus agalactiae is non-pathogenic for man, and mastitis, viewed strictly as an infection of the cow's udder, cannot be claimed as the cause of any known disease in man. The disease does, however, become of real public health significance when the udder is infected with the virulent *Streptococcus epidemicus* strain. Many milk-borne outbreaks such as scarlet fever and septic sore throat have been traced to milk from cows suffering from mastitis when the infectious organism was of a strain pathogenic to man. It has been established beyond question that milkers suffering from a streptococcus infection such as sore throat may infect cows' udders during the milking operation. The presence of mastitis may predispose the udder to invasion by other infectious organisms. Another predisposing cause is probably the intensive dairy practices of today and the stimulation of a large milk flow in the modern dairy cow. Experiments conducted at the Rockefeller Institute for Medical Research[51] have shown that cows kept under natural primitive conditions and not exposed to infection by stable confinement or forced to produce maximum milk yield for ten or more months of each lactation can preserve the usefulness of the udder for the purpose for which it was originally developed. The present demands placed on the dairy cow may be conducive to various physiological changes which render the udder more susceptible to infection.

Mastitis shows a high incidence of infection. Experience in this country indicates that it is present in 86 per cent of the herds, and that 26 per cent of cows have the disease. Milk and butterfat production is reduced about 25 per cent and milk quality lowered about 56 per cent. Its presence in a herd therefore constitutes an economic loss to the dairyman.[13]

Prevention and control of mastitis. The prevention and control of mastitis are subjects of interest to several groups—veterinarians, bac-

Table I. Microorganisms that produce inflammations of the bovine udder (mastitis)[9]

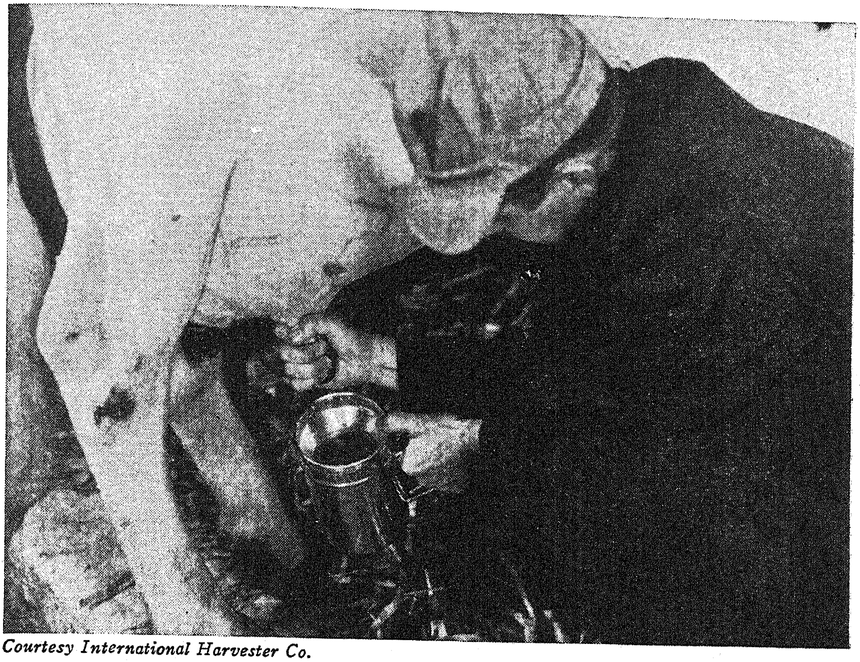
Scientific name	Prevalence in cattle	Transmissibility to man
Streptococcus agalactiae Synonym: *Streptococcus mastitidis,* etc. Possible variants of above: *Streptococcus uberis, Streptococcus dysgalactiae,* and others	Latent to active infection present in 50 to 95 per cent of bovine udders. Little known of distribution in other mammals	Identical organisms have been described from certain human infections, but the relationship between human and bovine infection, if any, is still obscure. Abnormal milk rarely causes stomach and intestinal upsets in man
Streptococcus pyogenes Synonym: *Streptococcus hemolyticus, Streptococcus epidemicus, Streptococcus scarlatinae, Streptococcus erysipelatis,* etc.	Rare, and normally derived directly from some human source	Readily gives rise to epidemics of septic sore throat, scarlet fever, erysipelas, etc., when infected milk is used in raw state
Staphylococcus aureus and *Staphylococcus albus.* Also called *Micrococcus aureus* and *Micrococcus albus*	Very common in the udder as well as on the skin of cattle. On occasion cause inflammations and formation of pus in the udder	The actively pathogenic strains sometimes produce a toxin that causes stomach and intestinal upsets in man
Aerobacter aerogenes, Escherichia coli and other coliform bacteria	Usually found when a search is made, but udder infections not really common	Probably never the direct cause of human diseases
Gangrenous or acute mastitis usually attributed to a mixed infection of the above bacteria or possibly to a virus	Not common, but usually fatal to cattle	Dependent on type of organism involved
Mycobacterium tuberculosis Synonym: *Bacillus tuberculosis*	Practically eradicated in the United States	Transmissible to human beings
Actinomyces bovis and *Actinobacillus lignieresi*	Found in cattle with lumpy jaw; also infect other bovine organs including udder	Little known regarding transmissibility to man
Brucella abortus, Brucella suis, and *Brucella melitensis*	The bovine organism is widespread; the porcine variety is found most commonly in hog-raising areas; the caprine variety is found in N. America only in Mexico and southwestern U.S.	Bovine variety least infectious for human beings. Caprine variety most infectious of the three. Cause of undulant fever or brucellosis
Corynebacterium pyogenes Synonym: *Bacterium pyogenes*	Common cause of pus formation in cattle and not infrequently found in udder	Not generally found in human beings

Note: *Pseudomonas pyocyanea* is occasionally found as a cause of udder infections. This organism produces a bluish or bluish-green pus.

teriologists, health officers, milk sanitarians, and dairymen. The milk sanitarian must be able to recommend measures to be followed to prevent this infection, since prevention is his major interest in dealing with the disease. He is directly concerned with the control and possible elimination of mastitis from a herd, but for the latter course of action he should advise the producer to engage the services of a veterinarian. A great deal of literature is available and a vast amount of research work has been done in the field of bacteriology in relation to mastitis, and no attempt is made here to cover all the studies reported. Recommended control measures are, however, generally quite uniform. Dr. C. S. Bryan, of Michigan State College, who has conducted exhaustive studies and research in this field, recommends the following control procedures:

1. Consult your local veterinarian.
2. Test the herd to locate the infected cows (physical examination and microscopic test*).
3. Dispose of the badly infected cows, detected by physical examination, for slaughter.
4. Segregate infected and suspected cows, detected by laboratory (microscopic) test, at one end of the milking line or in another stable until removed from the herd or recovered as a result of udder infusion treatment.
5. Upon removal of infected cows, clean the stall.
6. Test all replacement cows before purchase, or buy them subject to such test. (Isolate until tested.)
7. Procedures must be practiced, in raising heifer calves, to prevent udder injury and to prevent the sucking that breaks the seal on the teats, if they are to be used as good replacement cows.
8. Stable cows in properly constructed stalls or stanchions with plenty of clean bedding to prevent udder injuries.
9. Employ sanitary measures in the barn at all times:
   a. Before milking, wipe the udder of each cow with a clean cloth moistened with chlorine solution (200 p.p.m.).
   b. Discard the fore milk into a strip cup [see Figure 1].
   c. In hand milking, wash hands before milking each cow.
   d. Exclude people with "running sores" on their hands or "strep" throats from the milking of cows.
   e. In machine milking, dip teat cups into two separate pails of chlorine solution (200–400 p.p.m.) before milking each cow.
   f. Do not permit a calf to nurse in the milking line.

* Author's note: Chemical tests are also available, e.g., Brom-thymol-blue, Hotis, and the chloride test.



Courtesy International Harvester Co.

Figure 1. Flaky or abnormal milk may be detected by means of the strip cup

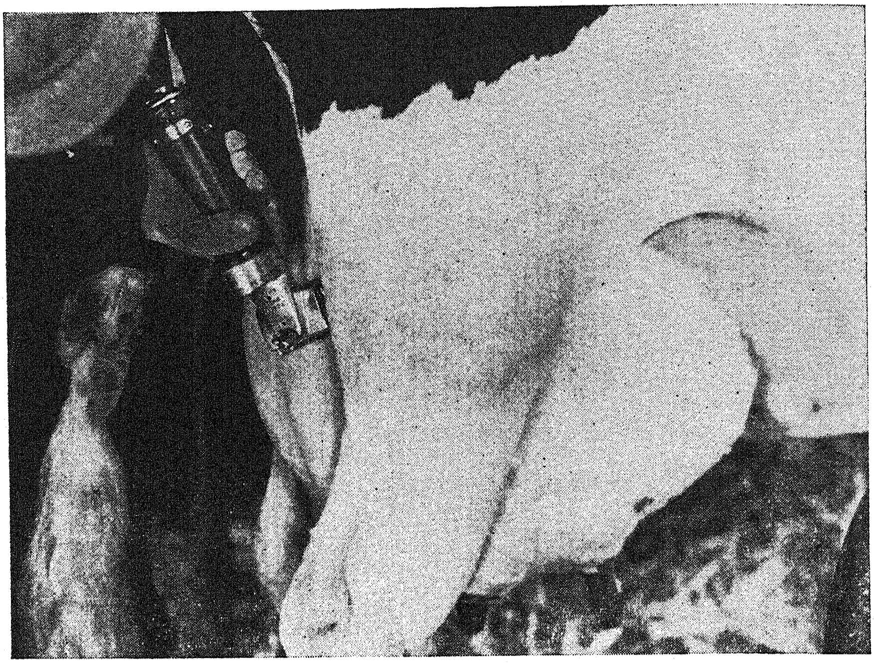
g. Use superphosphate or lime on the pavements and platforms.
h. Permit plenty of sunshine to enter the barn.
i. Milk infected cows last and properly dispose of their milk.

10. Proper preventive vaccination may be of value where the infected cows must remain in the herd for some time.

To eradicate the disease from the herd, it is necessary to eliminate all infected cows, including those not yet in the advanced stages of mastitis.[13]

Specific regulatory measures designed to control mastitis in dairy herds do not appear in most milk ordinances, although a general statement covering health of cattle is always included. The United States Public Health Service Milk Ordinance contains the following provision in connection with udder infections:

> Cows which show an extensive or entire induration of one or more quarters of the udder upon physical examination, whether secreting abnormal milk or not, shall be permanently excluded from the milking herd. Cows giving bloody, stringy, or otherwise abnormal milk, but with only slight induration of the udder, shall be excluded from the herd until re-examination shows that the milk has become normal.[84]



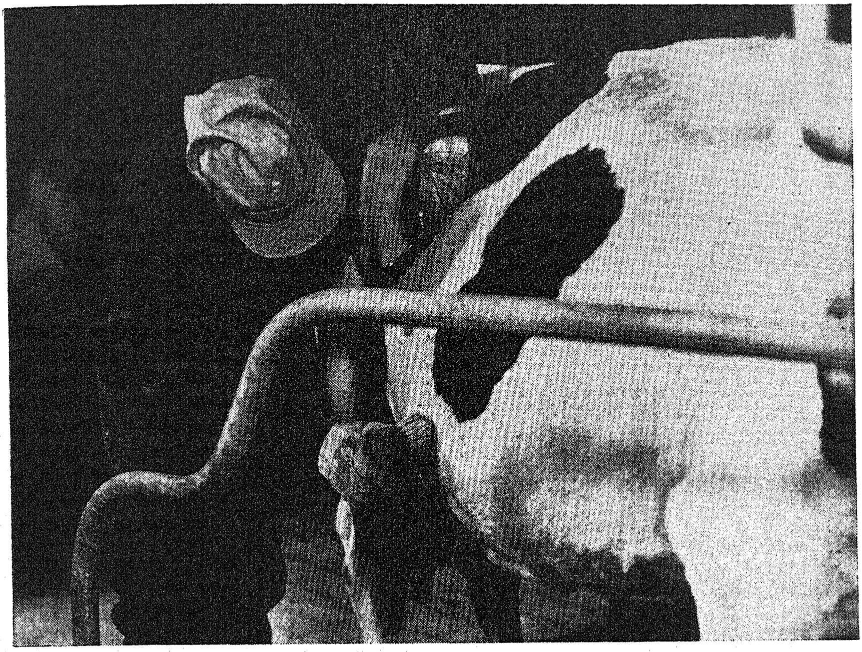
Courtesy International Harvester Co.

Figure 2. Clipping hair from hind quarters, flanks, and udder aids clean milk production

A regulation somewhat more specific in nature was passed by the Lansing, Michigan, Board of Health in 1935:

> All raw milk sold in the City of Lansing must be produced by cows free from streptococcic mastitis (infectious mastitis) as determined by two weekly tests by the microscopic method described in *Veterinary Medicine,* 30, 4 (Apr.), 1935. Animals producing such raw milk must be tested every 6 months thereafter and found free of infectious mastitis. Any reacting animals must be removed from the herd.[15]

Legislation alone is not, of course, the sole answer to this problem. The milk producer must be educated to understand the symptoms of mastitis, and his interest must be stimulated so that he will follow recommended control practices. Carrying out prophylactic measures against the spread of this infection prevents herd wastage and economic loss; the quality of milk likewise will be improved. The milk sanitarian is in a good position to advise the milk producer in this connection, and he should take advantage of it at every opportunity.

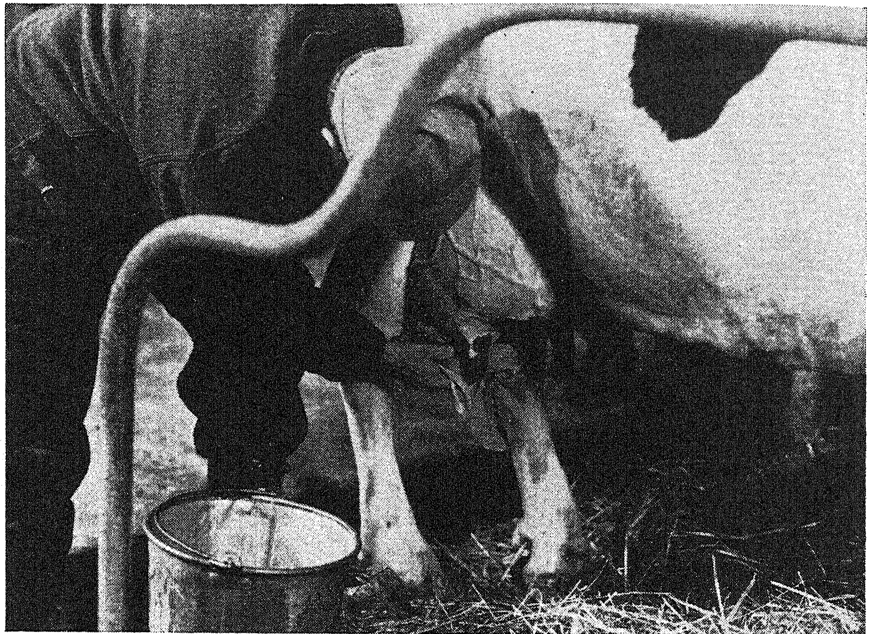


Courtesy International Harvester Co.

Figure 3. Currying and brushing the cow are essential steps in clean milk production

CLEANLINESS OF CATTLE AT TIME OF MILKING

The importance of properly grooming and cleaning animals before they are milked is so obvious that it hardly seems necessary to mention it, yet under practical farm conditions this procedure is frequently neglected or is carried out in a very haphazard manner. A primary step toward insuring cleanliness of cows' flanks, udders, and tails is the clipping of long hairs from those parts (see Figure 2). Although clipping is generally not required except in herds producing certified milk or where ordinances are specific in this connection, it is an operation which should be recommended to all milk producers. Sometimes milk companies maintain a supply of electric clippers, which are loaned to farmers as a means of encouraging them to keep their cows clipped. Dirt, manure, chaff, and other contamination which soil cows' flanks and udders are much easier to remove if long hair is clipped short. Whether the hair is clipped or not, the flanks, bellies, tails, udders, and teats of all milking cows must be clean at the time



Courtesy International Harvester Co.

Figure 4. Before milking, wash udder and teats with clean cloth moistened in bactericidal solution

of milking. A practical explanation of this requirement is that under normal farm conditions cows accumulate on their bodies quantities of manure, caked mud, dust, chaff, and long hairs; when such matter falls into milk during milking it contaminates the milk and adds large numbers of bacteria. Cow manure may contain the organisms of tuberculosis, and polluted water that has come in contact with the udder may contain organisms of typhoid fever or other intestinal diseases. To insure proper cleanliness of cows at milking time, the following steps must be taken:

1. Use curry comb and brush to clean the flanks and tails (see Figure 3). This should be done shortly before milking is started to give dust and loose hair a chance to settle and not get into the milk. Wash loose any caked manure.
2. Use a bactericidal solution to wash the udder and teats of each cow (see Figure 4). Wipe dry with a clean cloth. Change the solution when necessary, usually after the solution has been used on 6 to 8 cows. Use damp cloth to wipe the flanks.

How this procedure, when carefully observed, affects the bacterial content of milk is shown in the following tabulation:[87]

Milking conditions	*Bacteria per cc. of milk*
Cows dirty, udders and teats not washed, open pail, sterilized	86,000
Cows clean, udders and teats washed, covered pail, sterilized	2,700

In order that the sanitarian may be absolutely sure that cows are clean at the time of milking, it is a wise practice to occasionally make an inspection at milking time. Of course the appearance of the cattle in the stable at times other than the milking period can also be used to indicate whether the animals are being kept in a satisfactory condition.

THE FARM WATER SUPPLY

The water supply for dairy use must be of safe, sanitary quality. In nearly all cases it will be derived from a private source, usually a well. The sanitarian must recognize the significant part water plays in nearly all dairy operations and must make certain that the water system is properly located, constructed, and maintained, and that the quantity is adequate. Sanitarians sometimes become so engrossed in procedures relating directly to equipment and methods of milk production that the water supply may be neglected or simply taken for granted. Because the sanitarian will be fully acquainted with recommendations of his State Division of Sanitary Engineering dealing with the safeguarding of private water supply sources, he is in an admirable position to advise milk producers on this subject. In addition, he should study carefully the sections in the United States Public Health Service Milk Ordinance and Code (1939 or later edition)[84] which discuss the dairy water supply in detail. If a supply cannot be changed to meet recognized standards or if it is judged unreliable, the sanitarian should require that water used for utensil washing be boiled and that a bactericide be used in the final rinse, or that a small chlorinator be installed at the well where water under pressure is provided. Water supply sanitation of itself is sufficiently important to merit special and thorough study, and texts and special bulletins devoted exclusively to it should be consulted. At this point, however, it is necessary to emphasize and to reaffirm the importance

of an accessible, abundant, and safe water supply for dairy use, for the following reasons:

1. To facilitate the liberal use of water for cleaning equipment and utensils and for handwashing;
2. To overcome the possibility that a contaminated supply may be used for cleaning utensils and containers;
3. To aid in the prompt cooling of milk, which requires the liberal use of water;
4. To assure the dairyman, his family, and employees a safe and potable supply for drinking and domestic use.

DISPOSAL OF WASTES

The disposal of human excreta and domestic wastes is a critical and often neglected sanitary problem on many dairy farms. If excreta disposal facilities are not properly located, constructed, and operated, infection may be carried from the excreta to milk by flies or through contamination of water supplies; or, if discharged into streams or on to low, swampy land, excreta may contaminate cows wading in such places. The following systems are considered satisfactory if they are in good order:*

1. Flush toilets discharging into a public sewer (rarely at a dairy farm) or into a septic tank provided with a good sub-surface tile drainage system.
2. Chemical tank toilets.
3. Septic tank toilets equipped with either a steel or a tight concrete tank.
4. Sanitary pit privy.
5. Sink, laundry, and milk house wastes discharged into a septic tank or into a suitable concrete or tile drain, or in certain instances into a properly maintained open drain.

All types, combinations, and conditions of these systems will be found by the sanitarian when he investigates farm waste disposal facilities: water-carried waste may be discharged into a stream, on to low, swampy land, or into a cesspool; septic tank effluent may be found flowing out on to the ground surface; sink waste may be found discharging down a wooden trough or through a piece of eavestrough

* Consult Item 10r of the United States Public Health Service Milk Ordinance and Code, 1939 edition,[84] other texts, and state health department bulletins for more detailed information on this subject.

pipe to a point near the farm house; a privy meeting no acceptable sanitary standards is likely to be found in use. In addition, the human excreta disposal problem is not always solved even when approved facilities are provided. The practice of defecating and urinating about the dairy premises is not uncommon on the part of some milk producers and handlers whose personal practices are careless. Such persons should be excluded from the milk shed after due warning.

The sanitarian who is able, through education and counseling, to effect solutions to problems of waste disposal around the dairy will make a real contribution to milk sanitation and to the public health.

THE DAIRY ENVIRONMENT

The subject of a sanitary environment about the dairy premises is rather broad in application, but in general it relates to such matters as the disposal of manure, the cleanliness of barns and pens where other animals than cows are kept, and the drainage and general condition of the barnyard.

The improper disposal of manure has a very direct relation to sanitary milk production. The manure may contain germs discharged from infected animals, and any cattle or hogs having access to the dunghill may in turn be infected. Shoes may carry infected manure into hay mows or silos, where it becomes mixed with the feed.[37] Also, improper manure disposal fosters the breeding of flies. The general condition, cleanliness, and drainage of the barnyard also have a definite bearing on the dairy environment: low places should be filled; manure droppings from animals should not be allowed to accumulate; approaches to the stable door should be sloped or graded and gravel fill or concrete should be placed where cows stand to drink at watering tanks.

The location and cleanliness of such other farm properties as hog pens, small farm slaughterhouses, and stables where other animals are kept relate directly to the fly hazard and must be controlled within reasonable limits. How far a hog pen or farm slaughterhouse, for instance, should be from the cow stable or milk house cannot be determined in exact distances, but the manner in which each is maintained can be regulated when the condition creates a hazard to milk. Manure disposal may be considered satisfactory when any one of the following procedures is carried out:

1. Spreading the manure upon fields. This is usually facilitated by having a manure spreader placed outside the barn under a litter carrier track. The litter carrier is emptied into the spreader, which when full is hauled to the fields.
2. Storing the manure for not more than four days in a pile on the ground surface in a location not accessible to cows or other animals. The manure is then hauled to the fields and spread.
3. Storing manure for not more than seven days in an impervious floored bin or upon an impervious curbed platform and then spreading or storing in a tight screened and trapped manure shed.[84]

Under practical farm conditions, recommendations (1) and (2) are the ones likely to be followed, with preference given to (1), since that practice makes more efficient use of farm labor, there is less delay in spreading the manure on fields, and less fertilizing value is lost.

Control of flies

The fly menace is closely related to nearly every operation carried on in the production and handling of milk. Many of the recommendations concerning the disposal of waste around the dairy premises have as their primary purpose the reduction of the fly nuisance to a minimum. Some characteristics of the fly should be mentioned:

1. Flies lay eggs in all types of refuse and filth such as human excreta, manure, spoiled silage, accumulation of wet and decaying hay and straw, dead animal matter; in fact, flies will propagate even in soil rich in humus.
2. An adult female fly lays eggs in batches of 100 or more which hatch in 12 to 24 hours. In fact, in midsummer it is estimated that from 10 to 14 days from the time of the laying of the eggs is sufficient to produce a generation of adult flies.
3. The fly cannot eat solid foods; thus solids must be rendered liquid before the fly is capable of partaking of them. To accomplish this he regurgitates the contents of his stomach on to the surface of the solid, then draws the liquid back into his stomach. The sanitary significance of such a characteristic can readily be appreciated.
4. The normal range of the fly can be circumscribed by a circle with a radius of approximately 1000 yards.[65]

Control measures such as the following serve to eliminate the breeding place of the fly:

1. Clean premises of piles of manure and other refuse. Remove spoiled silage from around base of silo. Practice approved methods for the

disposal of human excreta. Do not permit horse manure to accumulate.

2. Keep feed troughs clean in the cow stable. Keep bull pens and calf pens in a clean condition. Do not leave unwashed feed buckets around the premises.
3. In fly season, use outward-opening, self-closing screen doors on the milk house and keep windows screened. Do not leave unwashed milk utensils about the milk house. Flies have a very keen perception of odors which serves to guide them to food. Electrically operated fly traps may be installed in the upper half of screen doors. The electric fly trap is usually built in the form of a grid set in a frame and made to fit a particular opening. The bars in the grid are spaced about $9/32$ of an inch apart but do not appear to be a closure. The flies are electrocuted when they attempt to go through what appears to be an opening.
4. Ordinary cylindrical fly traps may be used for the destruction of adult flies. (See United States Department of Agriculture Farmers' Bulletin No. 734 for construction details.) These are generally baited with various sweets or fermenting materials; in fact, black strap molasses diluted with 3 or 4 parts of water is a very attractive bait and great numbers of flies can be caught in this type of trap.
5. Chemicals, poisons, and sprays may be employed for the destruction of larvae and the adult fly. Ninety per cent of housefly maggots may be exterminated if infested manure is treated with a borax solution. Some plants may be injured if treated manure is used, but the fertilizing value is not lost for most vegetation if eighteen ounces of borax to thirty gallons of water is used. The borax should be stirred into the water and let stand twenty-four hours. Two and one-half gallons of this mixture will treat the manure from one horse for one day. The manure should be piled where it will drain, as this treatment is not so effective against flies when the manure is moist.
6. Good results may be had in treating pigpens, chicken yards, and garbage pits with a borax solution.
7. Formalin, one part to nineteen parts of water, is very attractive to flies, and is one of the most satisfactory fly poisons known. However, it is a violent poison and should be kept away from children or pets.[55]

Fly sprays which can be purchased commercially are commonly used by dairymen for killing flies on cattle and in the stable. Most of these sprays contain extracts of pyrethrum in oil and are quite effective. DDT (dichloro-diphenyl-trichloroethane) has already given astounding results against flies.* The United States Department of

* See Appendix, page 285, for more detailed discussion of DDT, including methods of preparation and use.

Agriculture, Bureau of Entomology and Plant Quarantine, has shown in practical spray tests that when walls and ceilings of milking barns and feed rooms were sprayed once with DDT in kerosene, the immediate reduction of flies was 95 per cent and for several months the population continued to be much lower than in untreated barns. For use in fly control in dairies, a 5 per cent DDT spray is recommended.

The main point of emphasis, however, is that the most productive way to control the fly is to do everything reasonably possible to eliminate breeding places. Other means of control are effective in destroying the adult fly, but they serve only as temporary expedients unless the premises are maintained in a sanitary condition.

THE MILK HOUSE

Milk house construction, including the proposed plan, the equipment to be installed, and the arrangement of equipment, is a subject which has received a great deal of attention from milk sanitarians, public health engineers, and agricultural engineering departments of state colleges, equipment supply companies, and concerns selling insulation materials and cement. In general, milk house plans have become reasonably well standardized, and specific instructions for planning and building are readily available to dairymen in bulletin form. The sanitarian should have an ample supply of such material on file and should be prepared to advise milk producers as to location, size, most economical type of construction, and equipment needed to make the milk house a convenient adjunct to proper milk handling.

A clear and concise statement summing up the reasons why a well-constructed and well-equipped milk house is essential appears in the United States Public Health Service Milk Ordinance and Code, 1939 edition. The applicable section is quoted herewith:

> There shall be provided a milk house or milk room in which the cooling, handling and storing of milk and milk products and the washing, bactericidal treatment, and storing of milk containers and milk utensils shall be done.
>
> 1. The milk house or room shall be provided with a tight floor constructed of concrete or other impervious material, in good repair, and graded to provide proper drainage.
> 2. It shall have walls and ceilings of such construction as to permit

easy cleaning and shall be well painted or finished in an approved manner.

3. It shall be well lighted and ventilated.
4. It shall have all openings effectively screened, including outward-opening, self-closing doors unless other effective means are provided to prevent the entrance of flies.
5. It shall be used for no other purpose than those specified above except as may be approved by the health officer; shall not open directly into a stable or into any room used for domestic purposes; shall, unless the milk is to be pasteurized, have water piped into it; shall be provided with adequate facilities for the heating of water for the cleaning of utensils; shall be equipped with two-compartment stationary wash and rinse vats, except that in the case of retail raw milk, if chlorine is employed as the principal bactericidal treatment, the three-compartment type must be used; and shall, unless the milk is to be pasteurized, be partitioned to separate the handling of milk and the storage of cleansed utensils from the cleaning and other operations. It shall be so located and conducted as to prevent any contamination of the milk or of cleaned equipment.[84]

These regulations not only establish the necessity for proper milk house construction, but also demonstrate the several uses for which the milk house is designed.

Location

The location of the milk house is a very important factor in the proper handling of milk. Obviously the milk house should be built on a clean, well-drained site, away from surroundings that might subject the milk to contamination. On the other hand, the milk house should be as convenient to the barn or milking stable as possible; in fact, this feature is at least as important as the selection of an ideal site, which may be too far removed. If attached to the barn, the milk house must not open directly into the stable. When the milk house is a part of, or is attached to, the barn or a dwelling, it may be made to comply satisfactorily if 1) there is an outside entrance but no direct entrance to the house or barn; or 2) if the entrance is through the barn, the opening is through self-closing doors, with a vestibule between and so arranged that both doors will not be open at the same time (doors with double-swing hinges can be used in this instance).

A milk house close to or attached to the barn has several advantages: 1) dairy operations are centralized, and therefore expedited,

with handling, utensil-washing, and cooling done in the same approximate location; 2) milk is not likely to be strained in the barn, where it would be exposed to barn odors, dust, and flies; 3) many needless steps are saved, reducing time and effort—when a dairyman with twenty cows takes the milk from each to a milk house fifty feet from the stable, he walks about three hundred miles in a year;[44] and 4) the dairyman need not go outside in stormy weather.

Size and construction

When it is realized that a one-room milk house must have a cooling tank, possibly a tubular cooler, vats for washing and sanitizing milk utensils, a hot water heating device, a utensil storage rack, a cupboard or cabinet for storing strainer parts, brushes and cleaning powder, and possibly a milking-machine solution rack, it is obvious that sufficient space must be provided to accommodate such equipment. Many milk houses on dairy farms today are too small, but fortunately the trend is away from small buildings measuring only 4 by 6 feet or 6 by 6 feet. A survey of milk house sizes made by the New York State College of Agriculture disclosed that of 320 milk houses surveyed, one out of every four was too small.[44]

There is rather general agreement now among milk sanitarians and others that the minimum floor area for a milk house of a dairy shipping milk to a plant should be 120 square feet (10 by 12 feet). This size is increased depending upon the output of milk in gallons. If the dairy sells raw milk at retail, the floor area is correspondingly increased and a two-room milk house is required to accommodate other operations incident to the sale of bottled milk. Table II is recommended as a guide for milk house size.

Table II. Suggested floor space for milk houses*

Milk output in gallons	Size (in feet) of milk houses: *Retail*	*Raw to plant*
Under 20	12 x 18	12 x 10
20 to 50	12 x 20	12 x 12
50 to 100	12 x 22	12 x 14
Over 100	12 x 24	12 x 16

* Adapted from U.S.P.H.S. Milk Ordinance and Code. Washington, Government Printing Office, Public Health Bulletin No. 220, 1939, p. 51.

A detailed description of construction features for milk houses is deemed inadvisable in this text, since such data are available from numerous sources. However, certain salient points should be mentioned. The milk house must be substantially constructed. Monolithic concrete, concrete block, cinder block, brick, tile, or a combination of these materials with wood frame is most commonly used. Excavations for the foundation and footing should be deep enough to place the footing on firm soil and to prevent damage by frost (see Figure 5).

If a cast-in-place concrete foundation is used, it should be brought up to a height of at least 16 inches above the floor level. The walls of the building may then be built up on concrete blocks, brick, tile, or poured concrete, or they may be of frame construction. If frame construction is used, the foundation walls should be of concrete or of an equally impervious material up to a height of at least 24 inches so that the framework is high enough to remain dry and to be above the point of splash (see Figures 6 and 7).

The floor of the milk house should be of concrete or an equally impervious material finished with a hard surface and sloped one-quarter to one-half inch per foot for proper drainage. The walls must be so constructed that a smooth, easily cleaned surface results. An interior finish should be encouraged. However, if cement blocks are used and the joints are smooth, an interior finish is generally not necessary. Unsheathed walls are satisfactory, provided the inside surface of the outer sheathing and all framing surfaces are smooth, dressed, and painted. The sanitarian is urged to exercise good judgment in connection with exterior construction and finishing of milk houses and not to require unreasonable refinements which have little bearing on the safe handling of milk.

Light and ventilation

Lighting of the milk house refers to both natural and artificial lighting. Window area should be at least 10 per cent of floor area. In a milk house 10 by 12 feet, for example, two windows 3 by 2 feet placed at opposite sides of the building will give ample natural light. Artificial light equivalent to one 25-watt electric light bulb per 100 square feet of floor area is considered adequate, although it is ad-

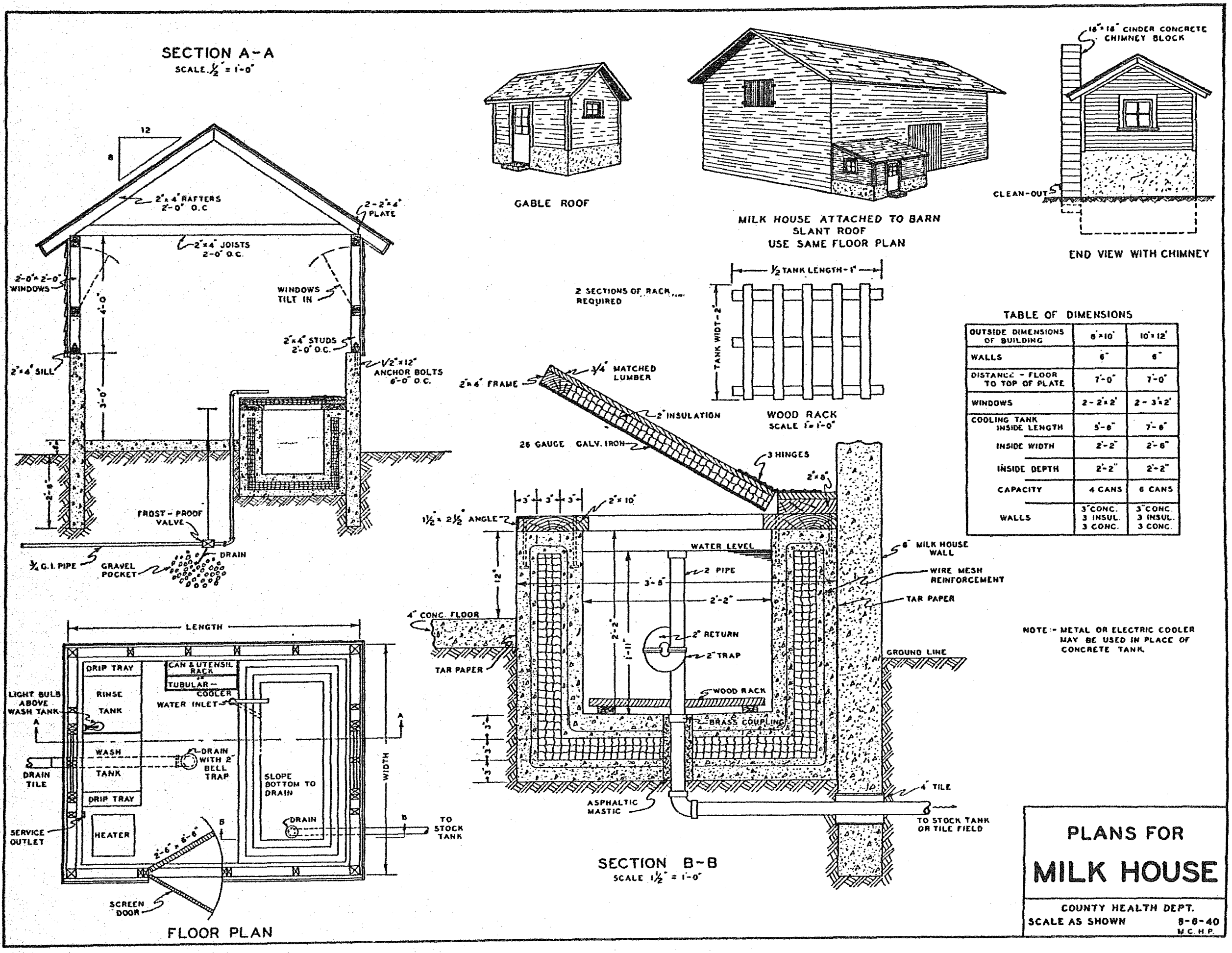
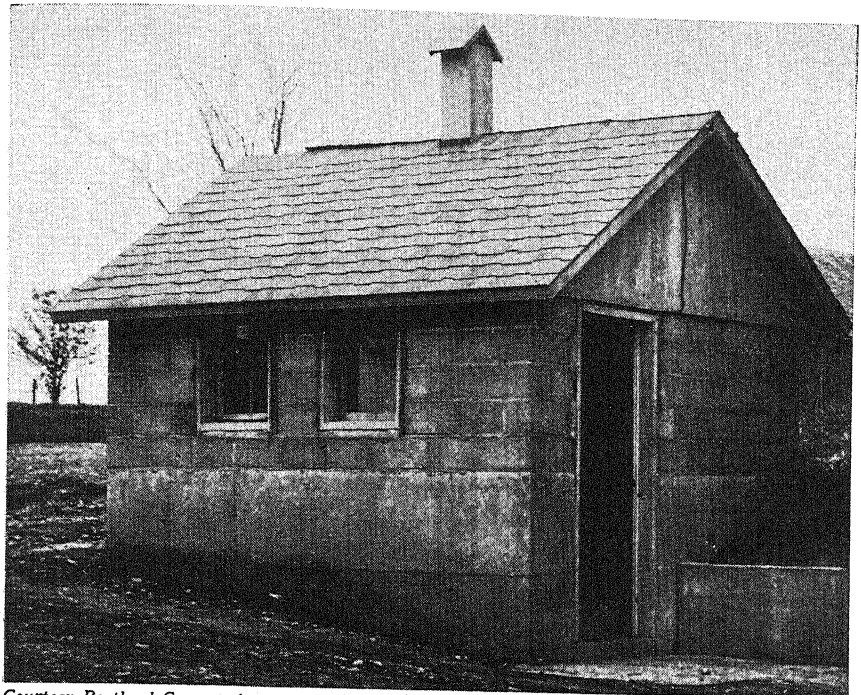


TABLE OF DIMENSIONS

OUTSIDE DIMENSIONS OF BUILDING	8'x10'	10'x12'
WALLS	6"	6"
DISTANCE - FLOOR TO TOP OF PLATE	7'-0"	7'-0"
WINDOWS	2 - 2'x2'	2 - 3'x2'
COOLING TANK INSIDE LENGTH	5'-8"	7'-6"
INSIDE WIDTH	2'-2"	2'-8"
INSIDE DEPTH	2'-2"	2'-2"
CAPACITY	4 CANS	6 CANS
WALLS	3" CONC. 3 INSUL. 3 CONC.	3" CONC. 3 INSUL. 3 CONC.

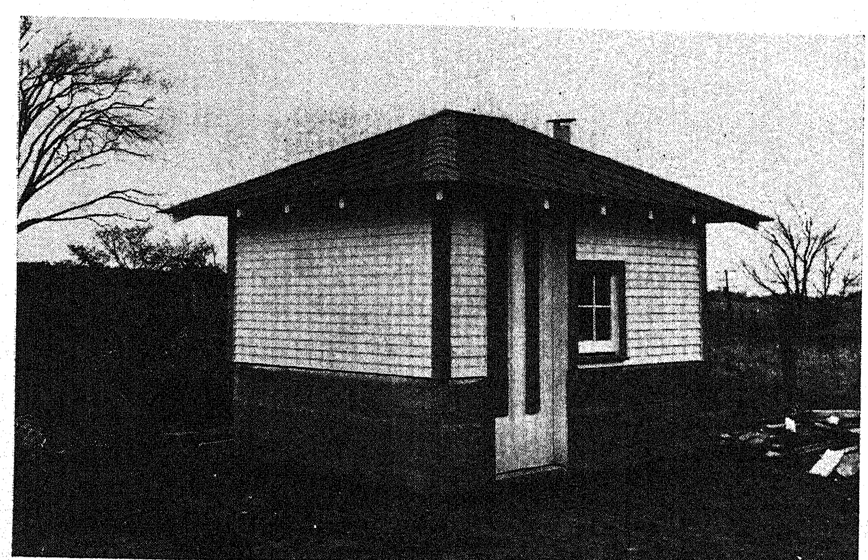
Courtesy W. K. Kellogg Foundation: Michigan Community Health Project

Figure 5. Plan and detail for milk house and cooling tank construction



Courtesy Portland Cement Assn.

Figure 6. Milk house of concrete block construction



Courtesy Michigan State College

Figure 7. Milk house of frame construction.
Note impervious foundation walls

visable to have a light placed directly above wash vats to facilitate inspection of utensils to make sure that they are thoroughly clean.

Ventilation of the average milk house is not a particularly difficult problem and can usually be accomplished by adjusting windows. Inadequate ventilation, however, can cause moisture condensation, dripping, and scaling of paint. Hinging windows at the bottom so that they may be tilted from the top and held partly open by means of sheet metal supports or chain stays is effective. If desired, a small screened roof ventilator may be employed. This can be arranged by cutting a hole approximately two feet square through the roof boards between rafters; two-by-fours or two-by-sixes are then nailed edgewise on top of the roof boards; roof boards, shingles, and ridge boards complete the ventilator. In certain cases, a small fan may be installed fitted in a frame equipped with metal louvres which open when the fan is operating and close when the fan is off.

WASHING AND SANITIZING MILK UTENSILS

Milk drawn from the udder of a clean, healthy cow contains no dirt and relatively few bacteria. To keep it in this condition, the utensils in which it is handled must not only be clean but must be treated to destroy bacteria. Utensils that look and feel clean may still contain an undesirable number of bacteria unless a sanitizing treatment is used.

The proper washing and bactericidal treatment of milk utensils are ever present problems on most dairy farms. On many farms, milk pails, strainers, and other milk-handling equipment are still washed in the farmhouse kitchen and then stored on the back porch or turned upside down on posts, ostensibly to dry in the sun. The proper washing and care of milk utensils are matters that require a great deal of patience and perseverance on the part of the milk sanitarian in order to educate the milk producer to carry out approved procedures satisfactorily.

Bryan, Devereux, and Mallmann, of Michigan State College,[14] in collaboration with representatives of the City of Lansing Department of Health, studied utensil cleaning and sanitizing on sixteen farms. Standard plate counts were made on milk utensils after they had been washed in the usual routine manner by the dairyman. Samples were collected daily from each of the sixteen supplies for a period

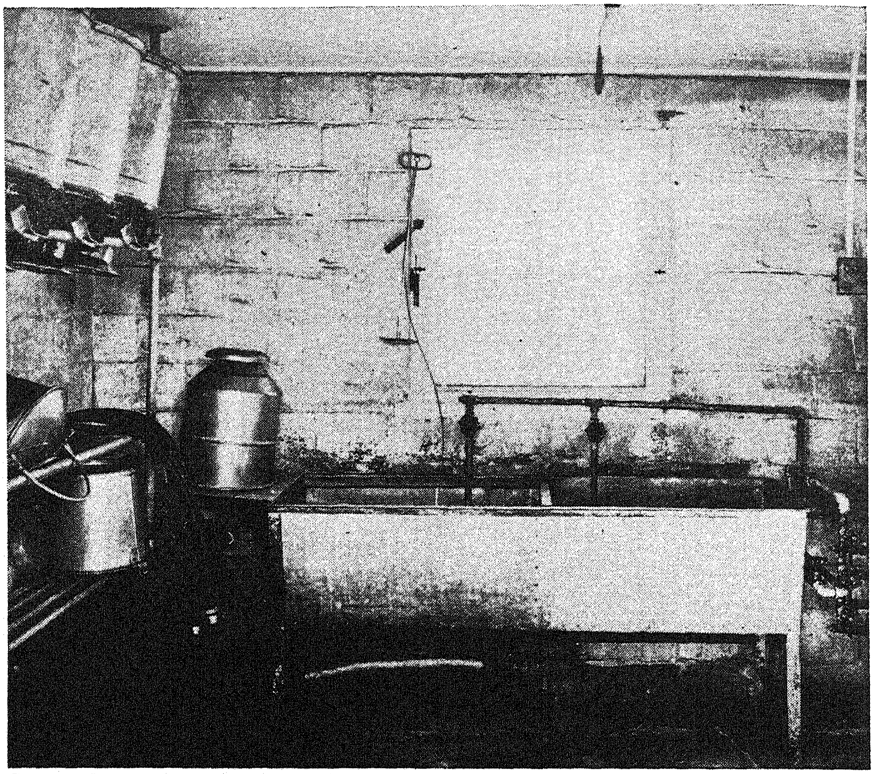
of one week. The mean average count for one week was 27,000 bacteria per milliliter, with a minimum of 14,000 and a maximum of 195,000. Following these examinations, each farmer was carefully instructed in the proper methods of cleaning and sanitizing. A few days later, another series of samples for one week was collected (the farmers were unaware that tests were being made). The results in this second series gave a mean average of 4,000, a minimum count of 2,000 and a maximum of 73,000 per milliliter. These tests show the significance of proper methods of utensil care and the value of giving producers careful instructions.

A second survey was made on six farms to determine the extent of utensil contamination. Five hundred cubic centimeters of sterile water were poured into a milk pail; the pail was tilted so that the water came in contact with all inside surfaces, then the water was poured through a strainer into a second pail; after the last utensil was rinsed, the water was returned to the sterile container. A few days later an unannounced visit was made to these farms. This time the utensils were sanitized by the inspector, who used a chlorine solution of 200 p.p.m. and then rinsed with sterile sodium thiosulphate water to inactivate the chlorine. The results of these two procedures are shown in Table III; the data are convincing evidence of the value of sanitizing dairy utensils.

TABLE III. Number of bacteria on dairy utensils[14]

Farm	Farm equipment rinsed with sterile water	Bacteria on equipment: *Utensils ready for use as found on the farm*	*Utensils sanitized with chlorine after washing*
1	1 pail and 1 strainer	20,000,000	500
2	2 pails and 1 strainer	10,000,000	6,000
3	1 pail and 1 strainer	3,500	2,500
4	2 pails and 1 strainer	8,000,000	31,000
5	2 pails and 1 strainer	900,000	1,500
6	1 pail and 1 strainer	3,000,000	2,500

It is difficult, if not impossible, to properly clean and sanitize utensils that are dented, rusted, or have open seams. Galvanized and



Courtesy Portland Cement Assn.

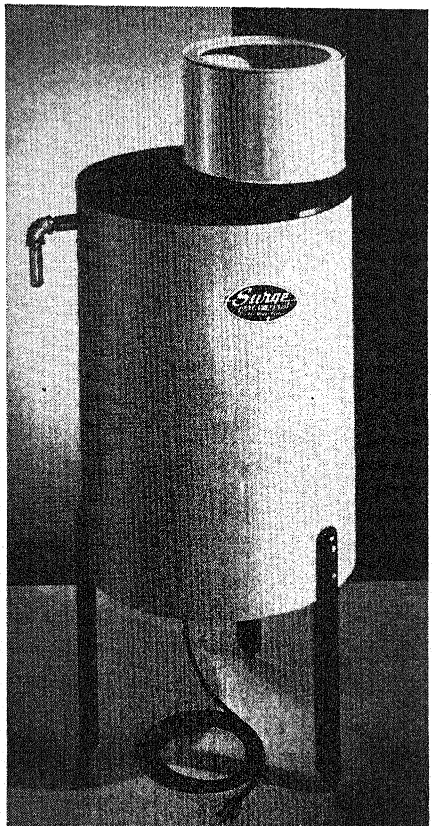
Figure 8. Two-compartment utensil-washing vat of a type suitable for the plant producer

granite ware utensils are not suitable; a heavily tinned surface or one of stainless steel is best (a hooded pail of stamped stainless steel, with a handle on the hood, is preferred). All seams should be soldered flush.

In order to wash and sanitize milk utensils effectively, vats or sinks of adequate size are necessary. Generally these are of galvanized sheet metal construction of a size sufficient to accommodate a 10-gallon milk can when the can is laid in a horizontal position. Inside measurements of these vats vary from about 28 to 32 inches in length, 16 to 20 inches in width, and 14 to 16 inches in depth. Vats can be purchased with single, double, or triple compartments (see Figure 8). Utensils are washed in the first compartment with warm water and a suitable detergent and are then completely submerged in the second

compartment in a chlorine solution or in water at a temperature of 170° to 180° F. for a two-minute period.

Electric automatic water heaters are now available to dairymen for installation in conjunction with wash vats in the milk house (see Figure 9). These heaters will deliver scalding hot water in a quantity ample for most utensil-washing requirements. They come in various



Courtesy Babson Bros. Co., Chicago

Figure 9. Electric hot-water heater suited to farm use

sizes from 10- to 18-gallon storage capacity. Other means of heating water may of course be used, including stoves burning oil, gasoline, coal, and bottled gas; however, if electricity is available on the farm the electric heater is probably preferable since it is automatic, danger from fire is reduced, and there are no objectionable fumes.

The essentials for the proper cleaning of utensils are hot and cold

water, fiber bristle brushes of various sizes, a good washing powder (not soap or soap powder), and a two- or, preferably, three-compartment vat with each compartment of sufficient size to permit immersing the largest utensil to be cleansed. Cleaning may be divided into the following steps:

1. Rinse in *warm* water. A hot water rinse will "set" the milk solids, tending to form "milkstone."
2. Wash in water as hot as can be borne by the hands. To this water should be added a good dairy cleanser. (Soap or soap powder should not be used because it is rinsed off with difficulty and works very slowly on milk solids; its properties of emulsification and deflocculation are limited.) Using a brush with fiber bristles, scrub the utensils thoroughly. (A dishcloth is very objectionable, as it tends to smear and slide over the surface instead of scrubbing off milk fat and solids.)
3. Thoroughly rinse the utensils in warm or hot water to remove the washing solution. The utensils are now physically clean and ready to be sanitized.

The sanitizing procedure

Steam, hot water, or chlorine compounds are effective sanitizing agents if properly used. Closed articles such as cans and pails may be treated by inverting over a jet of steam for one minute. Other utensils must be exposed in a steam cabinet for five minutes at 200° F. Unless the metal in the utensil is heated to a point much too hot for the hand to bear, little has been accomplished. Hot water is not effective unless the utensil is completely immersed for a period of two minutes at a temperature of 170° to 180° F.

Chlorine sanitizing agents can be purchased in liquid or powder form in convenient-sized packages. They should be added to tepid water to provide a chlorine strength of 100 to 200 parts per million as explained in the directions accompanying the package. Immerse the clean utensils in the chlorine solution for two minutes.

Proper care of milk utensils requires that they be stored on a sanitary metal rack inside the milk house. The sun is not a dependable sterilizing agent, for it cannot penetrate the inside of a can inverted on a fence post; it shines only part of the time, and any benefit is outweighed by the results of exposure to dust, flies, birds, and the weather.

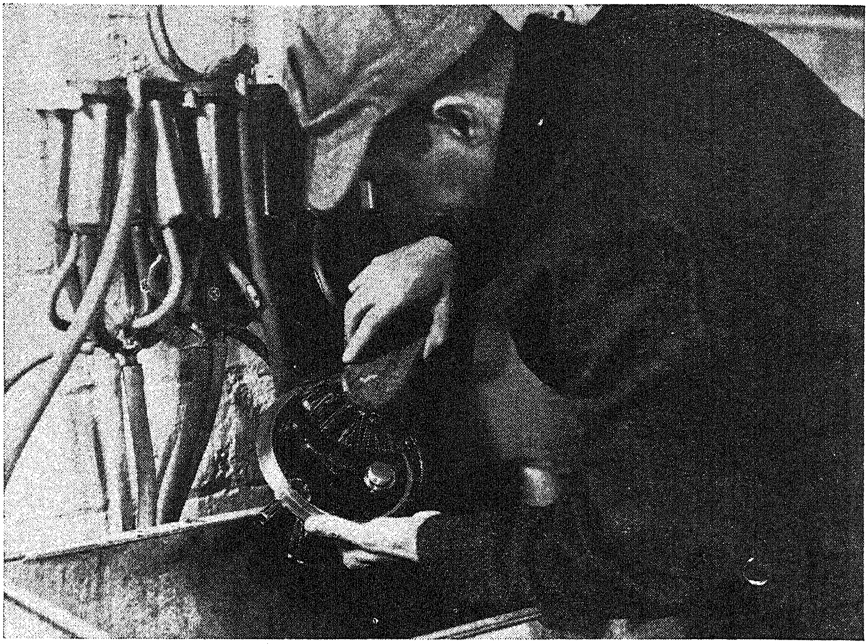
CLEANING MILKING MACHINES

The milking machine is being used more and more in the production of milk, and its labor-saving value is seldom questioned. In recent years the burden of many farm tasks has been lightened through the use of mechanical equipment, so it is entirely reasonable to expect the milk producer to use an apparatus designed to relieve him of the laborious work of hand milking. Since the advent of the milking machine, milk sanitarians have been well aware of the influence its proper cleaning and care have upon the sanitary quality of milk. Milking machine manufacturers have been placing increased emphasis upon proper cleaning, and most of their dealers receive explicit instructions in this connection. Milking machines are manufactured by about a dozen different companies, and although construction features vary to a certain degree, the principles of cleaning are quite similar—the method must be reasonably quick, simple, and effective. Elaborate time-consuming procedures, no matter how desirable they may appear to be, will not be followed by the average producer.

The Committee on Dairy Farm Methods of the International Association of Milk Sanitarians,[39] reporting in 1938, stated that clean milk of low bacterial content can be produced by using either the suction or the lye method of cleaning milking machines, and that it is unnecessary to completely disassemble a machine after each use. It was pointed out, however, that before using either of these two methods the machine must be free of all foreign matter, with rubber parts in good condition.

The suction method requires that at least four gallons of water, cold or tepid, be sucked through each unit immediately after use and before the motor is shut off, the teat cups being raised and lowered frequently. The raising and lowering of the teat cups increases expansion and contraction, thus helping to remove the milk residue. Then one gallon of hot water, not less than 180° F., should be sucked through each unit with the teat cups remaining in the hot water until it is all gone. The units and tubes should then be hung to drain and dry, and remain dry, until next used. Some people prefer storing units and tubes in cold water, brine, or chlorine solution.

The lye method utilizes the same preliminary step of sucking cold or lukewarm water through the units and tubes. The teat cups and



Courtesy International Harvester Co.

Figure 10. Pails and pail heads require washing and bactericidal treatment after each milking

milk tubes are then hung on a solution rack and completely filled with a weak solution of common lye (about 0.4 to 0.5 per cent);* the solution is left in them until the next milking, when it is drained out thoroughly. The disconnected pail head (see Figure 10) and milk pails should be washed and sterilized along with other metal utensils. The milk tube system should be taken apart once a week to prevent the rubber from sticking to the metal parts. Check-valves and vacuum lines need regular cleaning.

Since the average farm has a limited supply of hot water, the lye method is more suitable than the suction method. Lye in itself is cheap and easy to obtain, and the solution easy to make. Johns,[46] reporting on the use of lye at the Central Experimental Farm, Ottawa, Canada, gives the following advantages of lye over hypochlorite: lye is more readily obtainable; it retains its strength better both

* Dissolve a 13-ounce can of lye in one gallon of water. This makes approximately a 10 per cent solution. Six ounces of this 10 per cent solution to a gallon of water will yield a dilute lye solution of about 0.4 per cent strength.

in solid form and in solution; it does not deteriorate as rapidly when in contact with rubber and other organic matter; it dissolves casein and saponifies or emulsifies fat; it has a beneficial effect upon rubber parts; and it is more effective than chlorine compounds in the destruction of coliform organisms. Lye has two disadvantages, however: first, it will corrode aluminum parts in the milk tube system; and secondly, if the suction rinsing is not thoroughly done, small amounts of milk residue may remain, forming a precipitate of calcium phosphate, and a granular deposit will build up in the inner walls of the inflations.

Since the 1938 report of the Committee on Dairy Farm Methods, another development of interest in relation to milking machine care has appeared: this involves the use of a wetting agent solution for cleaning milking machines (a list of some of the companies selling wetting agents is given in the Appendix, page 253). The procedures, worked out at Iowa State College, claim to reduce the cleaning of a machine to a quick, simple chore.* The Iowa report states that even rinsing the machine in cold water immediately after using is not necessary. The operation is described as follows:

> 1. Add a tablespoonful of wetting agent to a pail of water at 120° F.
> 2. At the end of milking, suck the entire contents of the pail through the unit. Shake the milking machine pail to splash the solution over the inside surface. The solution can then be used to clean the other units. The seal-rubber rim and outside parts should be washed with a wooden-handled soft bottle brush.
> 3. Replace sealing rubber and suction head and suck a pail of boiling water through each unit.
> 4. Inspect tubes and hang them up to drain and dry.
> 5. For added assurance, run a pailful of chlorine solution through the machine just before using.
>
> The milking machine is not foolproof. The working of the machine, its state of repair, and cleanliness depend to a large extent upon the skill and effort of the operator.[42]

In concluding this discussion of milking machine care, it is necessary to mention that definite procedures have been established by law or ordinance in certain sections of the country. When such is the case, it is obvious that some of the shorter methods may not be per-

* The author wishes to state that he is simply reporting on the Iowa work and does not necessarily concur. It would seem that further study of this method is needed.

mitted. Reference is made particularly to the State of California, where the milk producer is required to use hot water for cleaning as well as for sanitizing a machine. There, rubber parts of milkers must be placed in a tank of water at a temperature of 185° F. and left therein for a period of twenty minutes. Experiments conducted at the University of California showed that heat sterilization gave consistently lower bacteria counts than chemical sterilization, and that the most reliable method of sterilizing milking machine rubbers was at a temperature of 185° F.[21]

The milking machine as an aid to milk production is here to stay. The sanitarian must recognize that fact, must familiarize himself with the details of each machine, and must take time to explain suitable cleaning procedures to producers. If unsatisfactory milk is being produced, it generally is no fault of the machine; rather, it is a failure on the part of the user to cleanse and care for it properly. In the final analysis, results are what count, and if the dairyman can produce a good quality of milk low in bacterial content he has demonstrated, among other things, that his method of caring for a machine is satisfactory.

COOLING AND STORING MILK

Within the past two decades definite advances have been made both in knowledge of milk-cooling requirements and in equipment designed to accomplish the task. The old-type open milk-cooling tank without cover or insulation is gradually being replaced by tanks insulated with cork board or similar material and constructed of concrete or steel. Expansion in rural electrification has given impetus to the use of mechanical refrigeration, which is becoming more prevalent on large dairy farms. Even with these advances, however, the problem of proper milk cooling on the farm is an ever present one. Poor cooling accounts for a tremendous annual economic loss to dairymen from rejected milk which fails to meet temperature requirements and bacterial standards.

Milk cooling in relation to bacteria count

The cooling and holding of milk at low temperatures to inhibit the growth of bacteria are essential steps in good milk production. In fact, if milk of sanitary quality is to be produced, prompt effective cooling on the farm is absolutely essential.

It is now a well-established fact, substantiated by a large number of studies, that if a satisfactory product is to result, freshly drawn milk must be promptly cooled to 50° F. or lower and held at or below that temperature until delivery. Although prompt effective cooling is highly desirable, it cannot be considered a "cure-all" for careless production methods. When carelessly handled, milk will have a high initial bacterial content, and even the most modern cooling device will not correct that difficulty. This is well illustrated by studies made at Michigan State College in 1942, when the multiplication of bacteria in different classes of milk held for sixteen hours at different temperatures was observed and recorded. The purpose of the study was "to show the effect of various storage temperatures on milk of various bacteria contents."[14] To determine the temperature to which milk must be cooled for storage overnight, samples of milk were selected from three farms to show low bacteria count, medium bacteria count, and high bacteria count, respectively. The samples were obtained from each farm immediately after milking and before cooling. Small portions of each sample were placed in a series of sterile test tubes. Samples of each milk were cooled and held at temperatures of 40, 50, 60, and 70 degrees F. for sixteen hours. Bacteria counts were made at hourly intervals. A storage period of sixteen hours was selected, since this represents the approximate time elapsing between the evening milking and delivery of the milk to the dairy plant in the morning. The results are presented in Table IV.

The data show that the bacteria in any milk stored at 40° F. for sixteen hours do not multiply appreciably. At 50° F. no increase in bacteria occurred in low-count milk, but in high-count milk a slight increase was evident. At 60° F. in the low-count milk the number of bacteria tripled but the total number was insignificant, but in high-count milk the count increased almost 50 times. At 70° F. the increase in bacteria was rapid, showing the danger of storage at this temperature for even short periods.[14]

Types of coolers

Although several means for cooling milk may be employed on the farm, the most common practice is to place the cans of milk in a tank containing cold water. (Dry storage, where the so-called "walk-in" cooler is used, may be mentioned, but this type of refrigeration is

Table IV. Bacteria counts of milk obtained upon storage at different temperatures, for varying periods of time, when cooled to those temperatures immediately after production[14]

Intervals at which bacteria counts were made (in hours)	Original bacteria count 5,000				Original bacteria count 100,000				Original bacteria count 960,000			
	40°	50°	60°	70°	40°	50°	60°	70°	40°	50°	60°	70°
1	5,000	5,000	5,000	5,000	100,000	100,000	100,000	140,000	960,000	960,000	960,000	960,000
2	5,000	5,000	5,000	5,000	100,000	100,000	100,000	170,000	960,000	1,000,000	1,500,000	2,000,000
3	5,000	5,000	5,000	5,000	100,000	100,000	100,000	200,000	1,000,000	1,000,000	2,000,000	4,000,000
4	5,000	5,000	5,000	5,000	100,000	100,000	100,000	280,000	1,000,000	1,000,000	2,500,000	10,000,000
5	5,000	5,000	5,000	5,000	100,000	100,000	100,000	300,000	1,000,000	1,000,000	3,000,000	20,000,000
6	5,000	5,000	5,000	5,000	100,000	100,000	100,000	342,000	1,000,000	1,000,000	5,000,000	48,000,000
7	5,000	5,000	5,000	5,000	100,000	100,000	110,000	360,000	1,000,000	1,000,000	10,000,000	55,000,000
8	5,000	5,000	5,000	5,000	100,000	100,000	118,000	400,000	1,000,000	1,000,000	15,000,000	60,000,000
9	5,000	5,000	5,000	5,000	100,000	100,000	130,000	440,000	1,000,000	1,000,000	16,000,000	68,000,000
10	5,000	5,000	5,000	10,000	100,000	100,000	132,000	484,000	1,000,000	1,000,000	15,000,000	75,000,000
11	5,000	5,000	5,000	10,000	100,000	100,000	138,000	500,000	1,000,000	1,000,000	18,000,000	80,000,000
12	5,000	5,000	5,000	15,000	100,000	120,000	146,000	550,000	1,000,000	1,000,000	20,000,000	85,000,000
13	5,000	5,000	5,000	15,000	100,000	140,000	160,000	564,000	1,000,000	1,000,000	28,000,000	90,000,000
14	5,000	5,000	10,000	25,000	100,000	145,000	169,000	590,000	1,000,000	1,000,000	30,000,000	curd
15	5,000	5,000	10,000	85,000	100,000	150,000	182,000	630,000	1,000,000	1,000,000	40,000,000	curd
16	5,000	5,000	15,000	120,000	120,000	160,000	200,000	657,000	1,200,000	1,400,000	50,000,000	curd

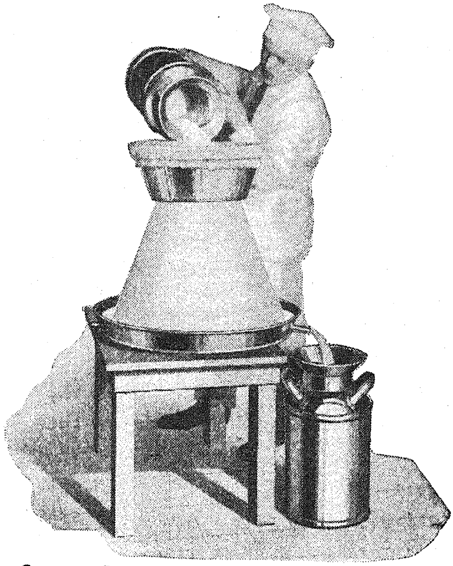
not in general use on the average dairy farm.) Devices to pre-cool or to partially cool milk before storing in the cooling tank are, however, quite commonly employed. In such cases the milk runs in a thin film over a cooler whose surface has been cooled by cold water, ice and water, brine, or a commercial refrigerant. Equipment which sprays cold water over the outside of the can is also used (see item 4 below).

The types of coolers or aerators generally employed for cooling milk on the farm are the following:

1. The plain conical cooler (Figure 11). Water and ice are placed inside the cone. At the top is a bowl with a row of small holes around the lower rim, from which the milk flows over the outside surface of the cooler into a receiving can.
2. The spiral corrugated cooler (Figure 12), somewhat similar in nature to (1), in which cold water enters under pressure through a pipe near the bottom into the inner spaces of the corrugation and flows around and up, coming out at the top where it flows to the outlet pipe. Above the cooler is a receiving bowl with a number of small holes around the outer edge of the bottom, through which the milk flows over the cooler. After passing over the corrugations, the milk is caught in a trough at the bottom, thence flowing into a receiving can.
3. The tubular or wall-type cooler (Figure 13). Milk runs over horizontal tubes while the cooling medium circulates inside.
4. The so-called "in-the-can" cooler (Figure 14). A portable device is set on top of the can. At least two types of "in-the-can" coolers are available: one has a small water-activated propeller which stirs the milk while water is sprayed on the outside surface of the can; another has a coil which is set into the can of milk—water circulates through the coil while the milk is stirred by means of a water-activated propeller.

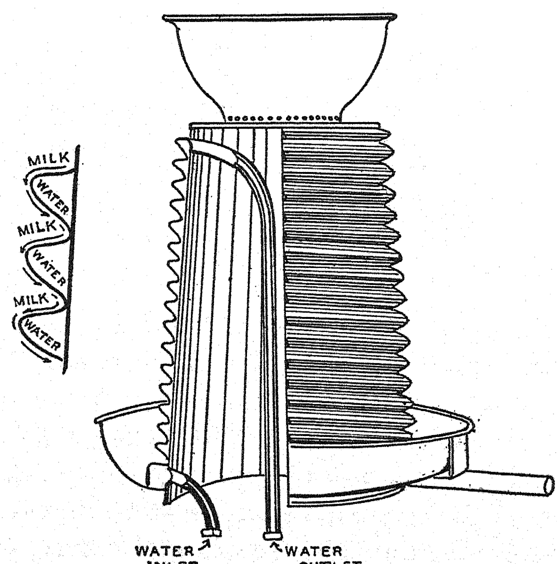
These pre-cooling devices speed up cooling, usually reducing the temperature of the milk from an initial 95° F., approximately, to within 3 to 6 degrees above the temperature of the cooling medium.

In trials made at the Oregon State Agricultural College,[63] milk at 90° F. was cooled over a 29-by-16½-inch tubular cooler to within 4½ to 6 degrees of the temperature of the cooling medium, with water flowing through the cooler at the rate of 4 gallons per minute. The Oregon experiments showed that the temperature reduction in milk cooled with the surface cooler exceeded the temperature reduction in milk cooled with one type of "in-the-can" cooler. With the temperature of the cooling water at 54° F. and with a rate of flow of 4



Courtesy Creamery Package Mfg. Co., Chicago

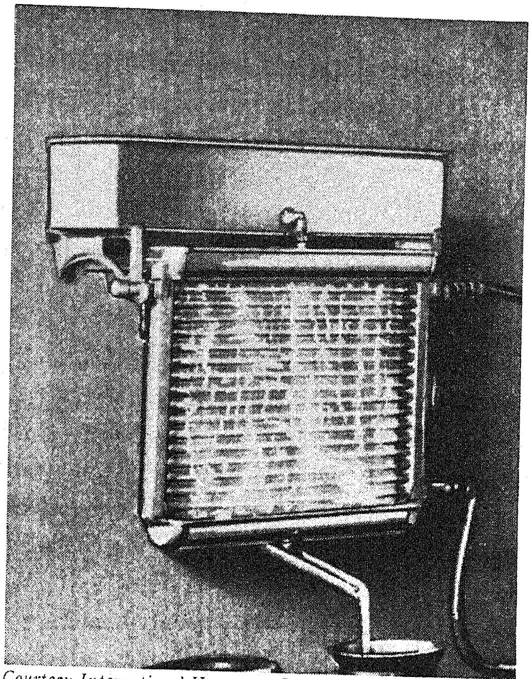
Figure 11. Plain conical milk cooler. Water and ice are placed inside the cone; milk runs over the outside to be cooled



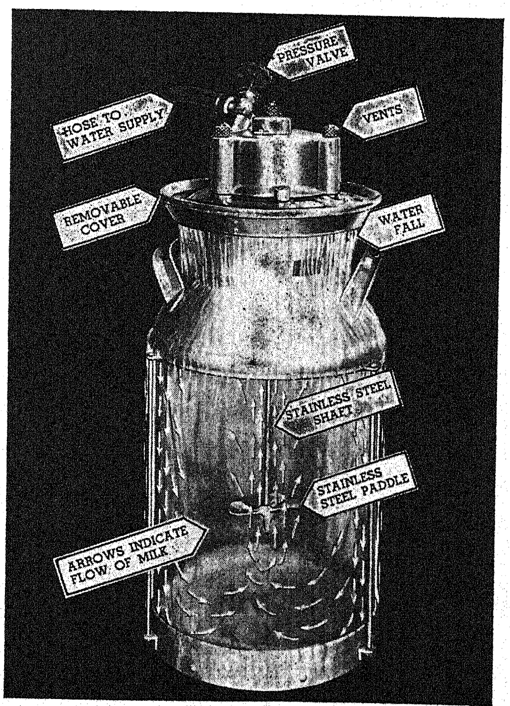
Adapted from U.S. Dept. of Agriculture Farmers' Bulletin No. 976

Figure 12. Spiral corrugated milk cooler. Cold water circulates on the inside; milk runs over the outside to be cooled

Figure 13. Tubular or wall-type cooler suitable for farm use



Courtesy International Harvester Co.



Courtesy Little Easaway Co., Saginaw, Mich.

Figure 14. "In-the-can" or shower-bath milk cooler

gallons per minute, it required fifteen minutes with an "in-the-can" type cooler to cool the milk from 90° to 58° F.; with a tubular surface cooler the temperature of the milk was reduced from 90.4° to 56.7° F. in ten minutes. Though the difference is not marked, the tubular surface cooler gave a lower temperature in a shorter time.

There are advantages in the use of pre-cooling equipment, but there are distinct disadvantages. When extra cooling equipment of the types described is employed, it means an additional piece of equipment to wash and sanitize, and unless this operation is carefully done the likelihood of introducing bacteria from unclean equipment outweighs the advantage of pre-cooling the milk. However, when pre-cooling equipment is properly cleaned and sanitized, it contributes very few bacteria to the milk. When electric refrigeration units are used for the storage of milk, it is generally considered unnecessary to use pre-cooling devices.

In most electrically operated cooling units the cooling water is maintained at, or slightly below, 40° F. Experiments conducted at Pennsylvania State College show the results of cooling evening milk in a correctly operated, mechanically refrigerated cabinet with coils on all sides, cans submerged to the shoulder, and some ice on part of the coils at the start. With an initial milk temperature of 91.8° F., the temperatures of the milk in the cans were: 52.2° at the top of the can and 45.5° at the bottom of the can at the end of the first hour; and 49° at the top of the can and 44.9° at the bottom of the can at the end of the second hour. The final average temperature of the milk at the end of 12 hours was 37° F.[61]

Several investigators have confirmed the fact that milk cools more rapidly when the water in the tank is agitated; in fact, some cooling tanks are equipped with agitators or other mechanical means to keep the cooling water in motion. It is recommended that such agitation be continued for at least an hour after cans of warm milk have been placed in the tank. However, agitation of the milk in the can is of doubtful value since considerable contamination may be introduced into the milk from an unclean stirring rod.

Milk-cooling tanks

The advantages of insulated milk-cooling tanks over uninsulated tanks may be listed as follows:

1. Milk can be cooled with half the amount of ice, and consumption of electricity is materially reduced.
2. Milk can be cooled about ten degrees lower.
3. Milk can be cooled in about half the usual time.
4. Milk can be cooled by immersing the cans in water in winter as well as in summer.[38]

Explicit instructions for the construction of insulated milk-cooling tanks have been prepared by and are available through state agricultural extension departments and companies selling insulation material and cement.* The milk sanitarian should be well versed in the construction of insulated concrete cooling tanks so that he can advise the producer concerning the best type and size to fit a particular situation. When planning a campaign for the construction and use of insulated tanks, the sanitarian should do the following preliminary work:

1. Enlist the assistance of the state agricultural engineering department. It may be willing to construct a model tank for demonstration purposes: in Michigan a model was built of wood at the State College and carried from place to place on a small trailer; the agricultural engineer then met with farmer groups and explained construction details. Meetings were arranged through the health department.
2. Provide a supply of bulletins and descriptive literature on insulated tank construction for distribution among producers.
3. If a health department regulation has been enacted, see that local building supply houses have a copy of it along with bulletins describing materials used and directions for tank construction. Be sure the insulation material can be obtained. For example, 3-inch waterproofed insulation material is not generally stocked by most local suppliers, but if there is to be a demand they will obtain it. Waterproofed insulation is essential, since most insulating materials lose their value when wet.
4. Investigate local jobbers who may be able and willing to stock prefabricated steel insulated tanks. Be sure the manufactured tank meets health department requirements.
5. After a reasonable length of time (generally six months to a year is sufficient), check up on producers for compliance with the new regulations. Unless some unforeseen obstacle intervenes, extensions should not be granted and producers failing to provide a proper tank should be excluded until they do.

* Several companies manufacture prefabricated steel insulated cooling tanks which may be satisfactorily used.

6. Keep on file a list of local masons or carpenters who do construction work for farmers. There is no objection to giving farmers the names of several reputable mechanics who are skilled at this work. Avoid quoting exact construction prices, however, as no two jobs are exactly alike.
7. When a well-constructed tank has been built at a farm, advise other neighboring producers to inspect it.

Experience in some markets has indicated that the wording of a regulation should be such that producers having concrete tanks which are adequate in size and in good condition should not be required to tear them out. In such cases, simply requiring a tight-fitting insulated cover is a reasonable demand. It is not advisable to attempt insulation of the ordinary galvanized stock tank, since these tanks rust out rather rapidly, are not sufficiently durable, are rather difficult to insulate, and are not well suited for milk-cooling purposes. Concrete is so much more satisfactory that it is reasonable to require its use.

The size of the insulated tank to be built will depend upon the number of cans to be cooled. For efficient cooling the tank should hold about 3 gallons of water for each gallon of milk. Furthermore, a safe rule to follow is to allow 3 pounds of ice for the complete cooling of each gallon of milk in well-insulated tanks. Where concrete construction and 3-inch insulation material are used, tank sizes have been reasonably well standardized. Table V shows tank sizes based upon the number of 10-gallon cans of milk to be cooled (the inside width of the tank, 36 inches, and the inside depth, 27 inches, remain constant as shown in the table).

In addition to proper size and construction, the tank must be

TABLE V. Dimensions of insulated milk-cooling tanks[66]
(tanks are 36 inches wide and 27 inches deep inside)

No. of 10-gallon cans tank holds	Inside length	Outside length
4	4 feet	5 feet 8 inches
6	6 feet	7 feet 8 inches
8	8 feet	9 feet 8 inches
10	10 feet	11 feet 8 inches
12	12 feet	13 feet 8 inches

equipped with a tight-fitting insulated cover. The value of a good cover is illustrated by results obtained at the Vermont Department of Agriculture. In a cork-insulated tank of 6-can capacity, with cover, and with an outside atmospheric temperature of 84° F., 10 pounds of ice melted in 12 hours when milk was cooled and held at a temperature of 40° F.[10] Using the same size cork-insulated tank without cover, 40 pounds of ice melted in 12 hours. Ice consumption is dependent largely upon the construction and size of the tank used and upon the temperature of the outside air. An insulated tank with a tight-fitting, moisture-proof, insulated cover reduces ice consumption by about 75 per cent.

The construction of an insulated milk-cooling tank is not particularly difficult, and excellent directions will be found in publications of the Portland Cement Association. Figure 15 shows construction details and tank layout; Figure 16 shows the finished tank. It will be noted that the tank is generally set along one wall of the milk house. Labor in handling milk cans is reduced by placing the tank partly below the level of the milk house floor.

Costs of cooling milk

The cost of cooling milk to 50° F. or below is a question frequently raised by the milk producer. Sufficient studies have been made by impartial authorities to determine such cost within reasonable limits. However, when milk-cooling cost is determined, a number of variable factors must be taken into consideration, the principal ones being:

1. The total quantity of milk handled
2. The total quantity of milk stored
3. Pre-cooling the milk with well water
4. The cooling water temperature
5. The type of equipment used, whether immersion cooling or cooling by dry storage
6. The effectiveness of insulation used in the storage cabinet
7. The room temperature[78]

In 1939 Roberts and Larson, of the Kansas Agricultural Experiment Station, studied the costs of cooling milk by four methods: the immersion, dry-storage, and walk-in methods, all using mechanical refrigeration, and the immersion method using ice. The approximate costs over a three-month period are shown in Table VI. Interest on

MATERIALS REQUIRED FOR INSULATED CONCRETE TANKS						
KIND OF MATERIAL	UNIT	AMOUNT OF MATERIALS NEEDED FOR EACH SIZE OF TANK				
		4-CAN	6-CAN	8-CAN	10-CAN	12-CAN
SAND	CU. YD.	1.0	1.3	1.5	1.8	2.1
GRAVEL - ¾" MAX.	CU. YD.	1.1	1.4	1.7	2.0	2.3
CEMENT	SACKS	10	13	15	18	20
3" VAPORPROOFED. INSULATION.	SQ. FT.	60	77	94	111	128
TAR PAPER - COVER	SQ. FT.	18	24	30	36	42
1"x 6"'S - COVER	LIN. FT.	78	104	130	156	182
2"x 10"'S	LIN. FT.	30	38	46	54	62
2"x 6"'S	LIN. FT.	4	4	4	4	8

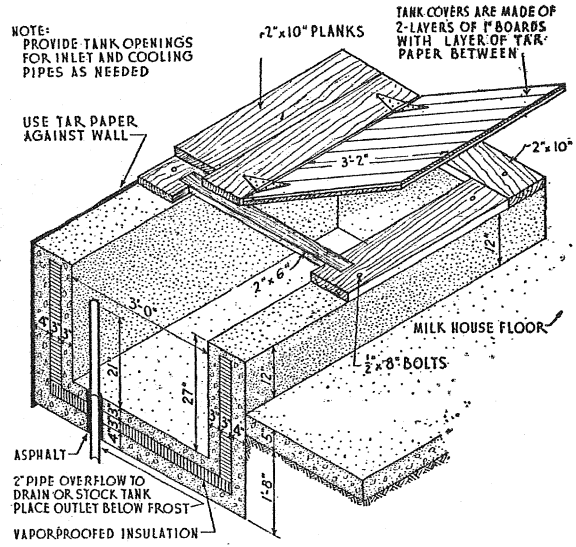
ADD MISCELLANEOUS MATERIAL SUCH AS LUMBER FOR FORMS, TAR PAPER, HINGES, PIPE FITTINGS, NAILS, ETC. (CONCRETE MIX 1:2¼ : 2½)

INSIDE DIMENSIONS OF INSULATED MILK COOLING TANKS*

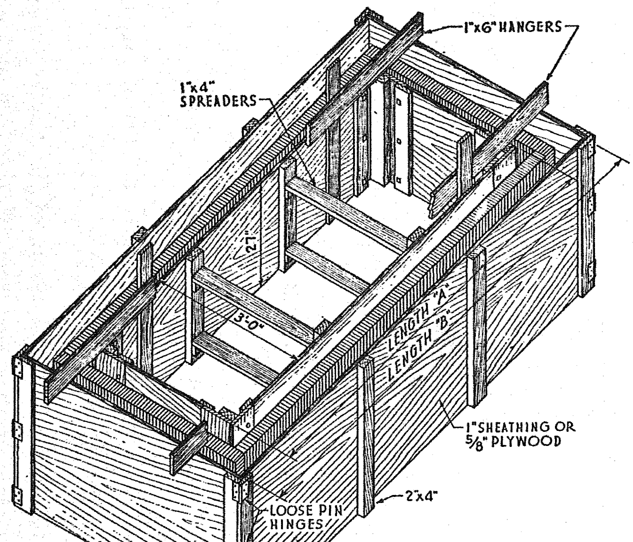
TANKS ARE 36" WIDE, 27" DEEP INSIDE

NUMBER OF 10 GAL. CANS TANK HOLDS	INSIDE LENGTH "A"	OUTSIDE LENGTH "B"
4	4'-0"	5'-8"
6	6'-0"	7'-8"
8	8'-0	9'-8"
10	10'-0"	11'-8"
12	12'-0"	13'-8"

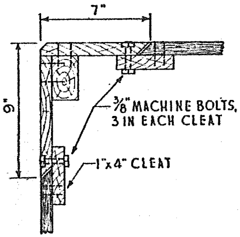
* THESE TANK SIZES PROVIDE SPACE FOR APPROX. 3 GAL. OF WATER FOR EACH GAL. OF MILK COOLED.



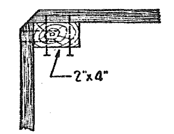
DETAILS OF INSULATED CONCRETE TANK



FORM DETAILS
FORM INTENDED FOR MANY REUSES



DETAIL OF CORNER INSIDE FORMS



ALTERNATE DETAIL OF INSIDE FORMS
FORM NOT INTENDED FOR MANY REUSES

Courtesy Portland Cement Assn.

Figure 15. Plan for the construction of an insulated milk-cooling tank

equipment cost, equipment depreciation and repairs, and operation costs were included in arriving at final figures. Electric energy cost was 3 cents per kilowatt hour and ice was figured at 30 cents a hundredweight.[69]

TABLE VI. Costs of cooling milk by four methods*

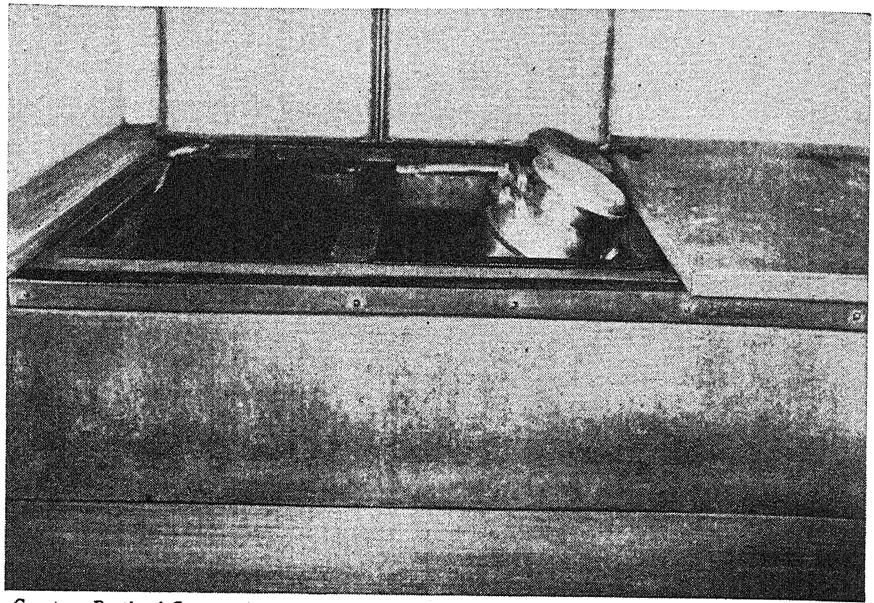
Refrigeration method	Cost per 100 pounds of milk
Mechanical wet storage	$.0805
Mechanical dry storage	.0916
Mechanical dry storage (walk-in)	.0916
Immersion, using ice	.37

* Adapted from Roberts, June, and Larson, George H.[69]

These studies point to the efficiency of mechanical refrigeration for farm use. The relatively low operating cost, combined with the quick, effective cooling job that the equipment can do, has already resulted in its increased use on dairy farms. It is safe to predict that, as more such installations are made, rejection of milk because of poor cooling and high bacteria counts will be greatly reduced.

KEEPING MILK COOL DURING TRANSPORTATION

A discussion of milk cooling and attendant facilities would certainly not be complete without mention of transportation of milk from farm to plant. The objective on the farm is to effect quick cooling and storage of milk at sufficiently low temperatures until it is ready to be loaded on the hauler's truck. From this point on, protected delivery is highly desirable; it is made possible by the use of insulated milk-hauling trucks, which are now mandatory in many markets. A properly covered and insulated truck prevents an appreciable rise in milk temperature during warm weather and protects the milk from freezing in transit during the winter. Enactment of a regulation requiring haulers to cover and insulate their vehicles generally meets with little or no opposition, provided a sufficient period of time is allowed for compliance. The regulation may state that truck



Courtesy Portland Cement Assn.

Figure 16. A finished insulated concrete milk-cooling tank

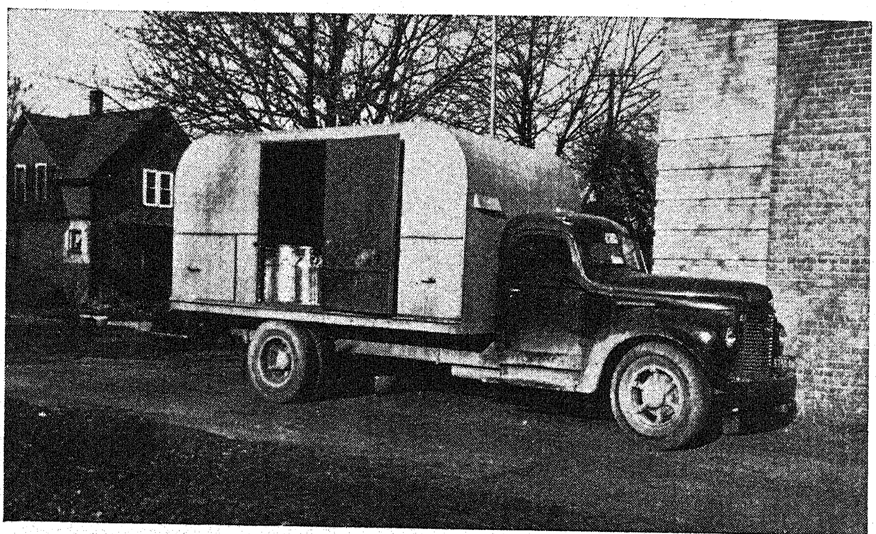


Figure 17. Insulated milk-hauling truck of the type shown here serves to protect milk while in transit

bodies are to be insulated with not less than one inch of approved insulating material to be used for lining the inside of the truck. Generally, truck body floors do not need to be insulated, provided they are of tight wood or metal, although some body manufacturers do insulate them. Producers who transport their own milk may use an insulated box mounted on a two-wheel trailer, or, in the case of a small producer, an insulated box is sometimes attached to the rear of a passenger car. It is undoubtedly true that there are many more critical factors in milk production than the insulated milk truck, yet it is a requirement that has considerable merit and should be generally encouraged. A satisfactory type of covered insulated truck is shown in Figure 17.

THE MILKING STABLE OR BARN

Although the actual planning of dairy barns and milking stables is basically a function of the architect and agricultural engineer, the milk sanitarian frequently is called upon for advice. Barn and stable plans are available to all milk producers from a number of agencies, such as state health departments, the United States Department of Agriculture, state agricultural college extension departments, building material firms, and manufacturers of barn and stable equipment. The producer, however, is not always informed of such sources, or may not make an effort to avail himself of such information. Consequently the sanitarian should be well versed in fundamental principles of design as these relate to the production of clean milk, and should have on file a quantity of bulletins giving plans and specifications for ready reference.

Many cow stables now in use are in barn basements, are poorly drained, damp, dark, improperly arranged, and fail to meet acceptable standards generally. Such situations always present difficulty. In fact, the producer who can carry out approved milking methods under such circumstances is the exception rather than the rule. It is obvious that all producers so situated cannot immediately be excluded from a market, nor can they be expected to build new stables, great though the need may be. But some point of compromise must be made which will effectively improve conditions without working an undue hardship on the producer.

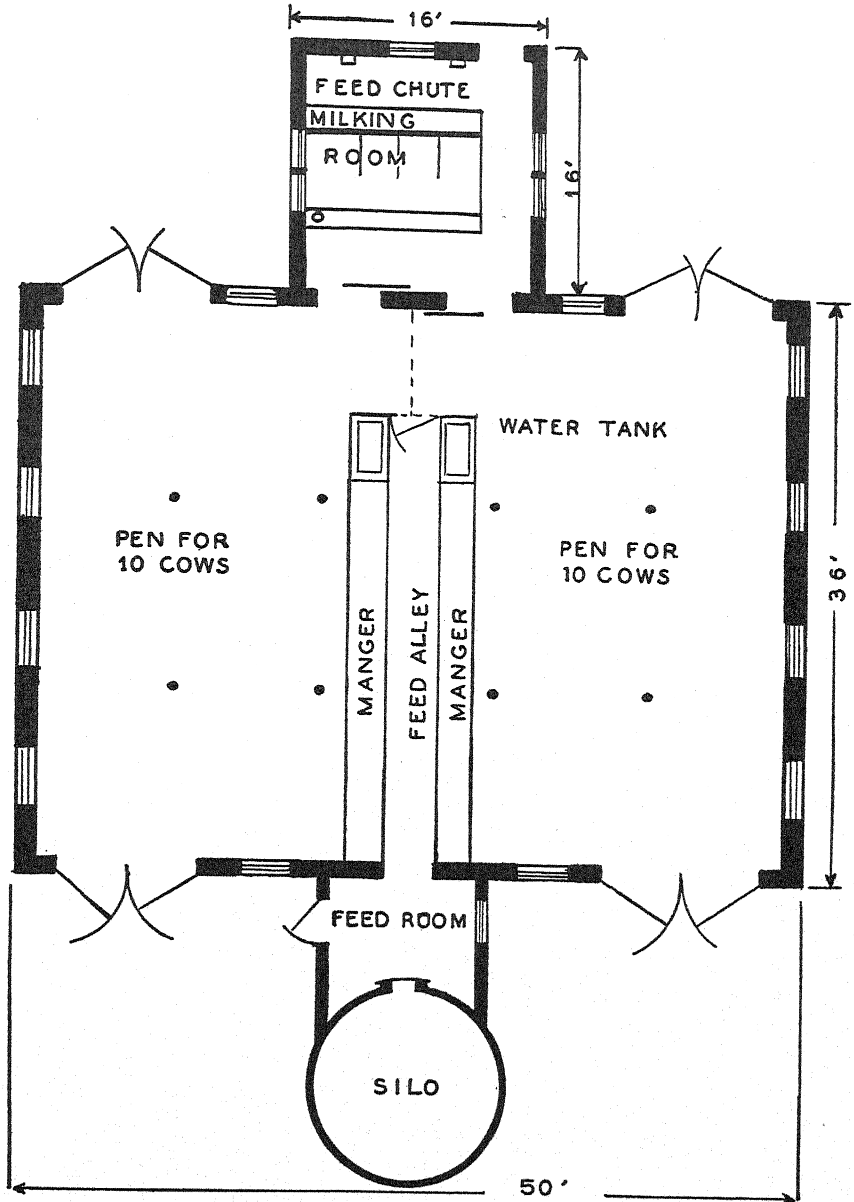
The sanitarian must be conversant with the following factors in stable construction and arrangement:

1. The construction and drainage of floors, spacing of stanchions, size of platforms, gutters, walks, mangers, and feed alleys;
2. The construction of side walls and ceiling;
3. Lighting arrangements, including the number and spacing of windows as well as provision for artificial light;
4. Ventilation.

Plan and construction

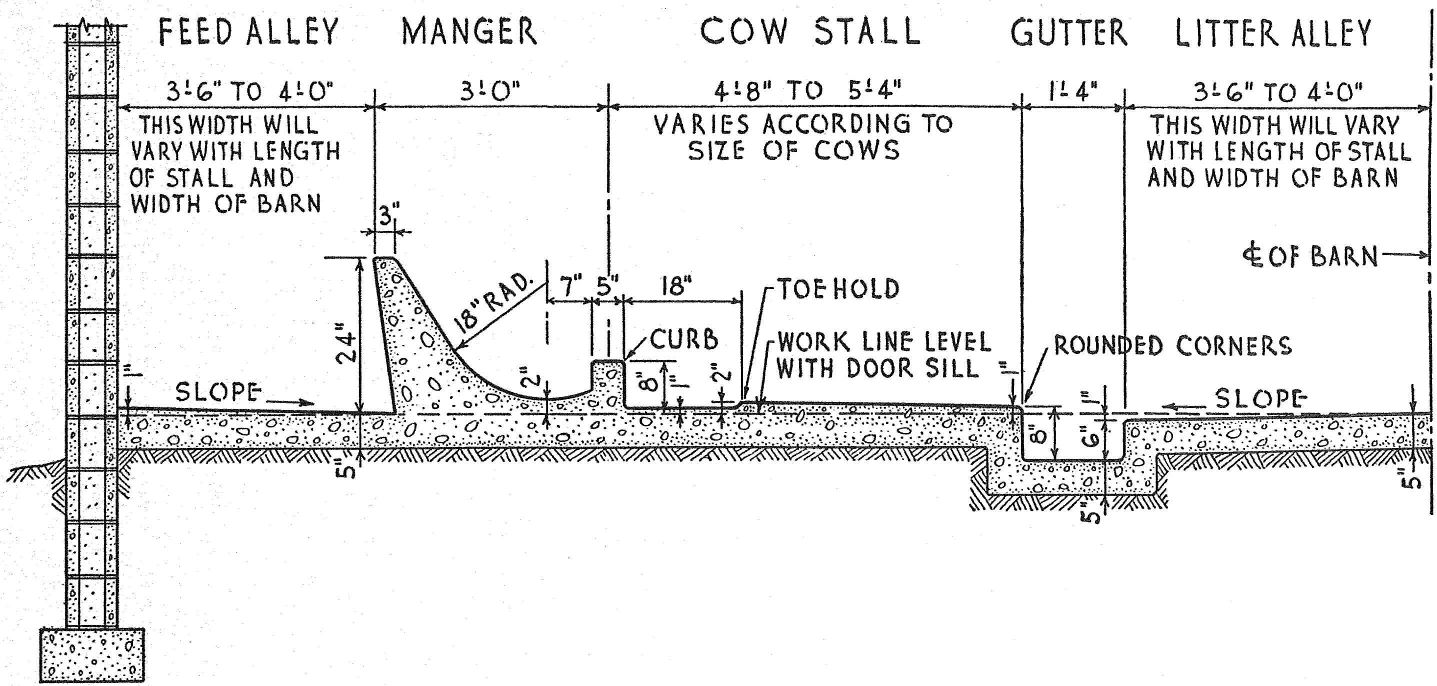
A plan which has been successfully followed in many instances is one by which the producer converts a portion of his stable or a part of the barn into a milking stable or "milking parlor." Such space is used for milking purposes only, with stanchions provided for four or five cows. Cows are brought in long enough for milking and are then turned back to the main stable. Similar in nature is the so-called "pen barn and milking room." After being milked the cows are turned loose into a large pen within the barn proper, each cow being allowed fifty to sixty feet of floor space. The pen is well bedded with straw, and cows feed from racks into which hay and ensilage are placed. Figure 18 shows a suggested arrangement for the pen barn plan. Both plans have merit, especially from the standpoint of economy, since it is easier to induce a producer to remodel one small section than it is to convince him that the entire stable should be rebuilt.

When remodeling is contemplated, certain well-established principles must be followed. One of the first involves the floor plan, including the arrangement of feed alleys, mangers, platforms, gutters, and litter alleys. In this connection, plans are now generally well standardized, although some variations may exist from one section of the country to another. Figure 19 shows a standard floor plan with a table of dimensions for barns of different widths.[66] The length of platform will depend, as indicated, upon the breed of cattle kept. Of particular interest for better sanitation is the high "feed saving" type of manger; it overcomes the objection to the so-called "sweep in" manger which may be conducive to the spread of disease among cattle. The width and depth of the gutter are important. It will be noted that the gutter is 8 inches in depth on the platform side and 6 inches on the alley side. The alley should slope slightly toward the outside edge



From Michigan Agricultural Experiment Station Quarterly Bulletin, November 1933

Figure 18. Suggested plan for a pen barn and small milking stable



Courtesy Portland Cement Assn.

Figure 19. Cross section of a typical dairy barn floor. Dimensions will vary depending upon width of barn

of the gutter. A gutter 16 inches in width is necessary, since a narrower one results in a littered platform and alley. The width of the litter alley is important, particularly where cows face in. If the litter alley is less than 4 to $4\frac{1}{2}$ feet in width, difficulty is experienced in keeping walls clean and it is inconvenient to clean the barn or to carry pails of milk along the alley behind the cows. In nearly all cases concrete has been accepted as the best material for stable floors. It is durable and impervious and may be kept clean with the least amount of labor and expense. When concrete is used for floors and platforms, it should be finished to give a gritty, non-slip surface. In certain cases cork, brick, or creosoted wood blocks laid in hot asphalt may be used for platforms or stable floors, but such installations are not especially common in the average dairy barn.

The construction of side walls and ceiling is important for stable cleanliness. Side walls must be of smooth construction, with lower walls of concrete or other impervious material extending to a point $3\frac{1}{2}$ feet above the floor. If frame construction is used, the upper walls need not be sheathed as long as the exposed surface is in good repair and can be kept clean. When there is a second story above the part of the barn where cows are milked, the ceiling should be tightly sealed to prevent dust and chaff from sifting through and falling on cows or getting into the milk.

For new frame construction, the side walls and preferably the ceiling should be painted or whitewashed. In newly constructed barns, paint is recommended, but either paint or whitewash should be applied at sufficiently frequent intervals as an aid to cleanliness. Whitewash should be applied at least once a year—in northern climates preferably during the summer or early fall in preparation for housing cattle inside during the winter. If the stable walls are constructed of finished concrete, concrete block, tile, brick, or similar material, painting generally is not necessary; however, even with these materials painting or whitewashing is desirable. Painting walls in light color greatly aids in light reflection and encourages cleanliness. In one-story barns the joists and rafters of the roof structure need not be painted or whitewashed, but they must be kept clean. Material attached to rafters to make the ceiling tight should be substantial; in general, and especially in the colder climates, matched lumber gives one of the best and most permanent ceilings.

Lighting

Lighting of the stable is of course highly important. Good light is conducive to cleanliness and greatly aids in carrying out operations efficiently. Sunlight is considered essential to the health of the dairy cow and tends to destroy disease organisms within the stable. Four square feet of window space per stanchion, evenly distributed, is recommended for new stables or for those being remodeled. For some types of existing stables where this standard cannot be met, as many windows as can reasonably be added should be required. The height of windows should always be greater than their width, so that as much floor area as possible is exposed to the sun. It goes without saying that in order to secure maximum natural light, windows must be kept clean.

Provision for artificial light must of course be made, since milking operations may be carried on early in the morning or at night. There should be a sufficient number of light fixtures in working order to insure that cleaning and milking operations can be efficiently carried out. This is generally left to the judgment of the sanitarian, since no definite standards have been established for the number of fixtures or for the size of bulbs to be used. Fixtures should be evenly spaced, with adequate light provided for litter alleys particularly, since it is from this point that the milker carries on most of his operations.

Ventilation

Ventilation of the stable is an item of major importance, especially in localities where cows have to be housed inside during the cold weather. Most milk ordinances, however, simply specify that adequate ventilation shall be provided, that overcrowding of animals shall be avoided, and that sufficient fresh air shall be admitted at all times. There are certain ways in which the effectiveness of ventilation may be judged, in addition to those employing observation and smell. One standard, though not infallible, is based upon the number of cubic feet of air space per cow. In northern climates, 500 to 600 cubic feet are sufficient, whereas in the South somewhat more may be needed because of the long period of warm weather. While the amount of cubic air space per cow in a stable is not necessarily an indication of good or bad ventilation, it is considered desirable to have not less than 500 nor more than 1,000 cubic feet for each animal.[64]

Marked variations in temperatures within the stable will indicate lack of control facilities or improperly operated ventilators. Condensation of moisture on side walls and ceiling is another criterion. The air should be fresh and clean to the smell, there should be no pronounced drafts over any of the stock, and there should be an appreciable movement of air inward at intake ventilating flues and outward through exhaust flues.

A good ventilation system if properly installed and operated will accomplish the following: 1) supply without draft the abundance of fresh air necessary to the health and comfort of cows, 2) make possible effective control of barn temperature—45° to 50° F. is considered a satisfactory temperature, 3) preserve the building and the feed stuffs from mold and rot due to excessive moisture and make spontaneous combustion less likely, and 4) provide a measure of disease prevention and control.

SUMMARY

This chapter on essentials of sanitary milk production has pointed out certain salient features necessary for safe milk production and handling on the farm. Some items have not been covered, such as the care of milk stools, whitewash formulas, types of dairy detergents for utensil washing, utensil storage racks, and bottling and capping equipment for the producer-distributor. An attempt has been made, however, to present material from the standpoint of practical field application. To supplement the information presented herein, the reader is advised to consult and study other texts (see Appendix page 249). Particular attention is called to Items 1r to 26r, inclusive, appearing in the 1939 edition of the Milk Ordinance and Code recommended by the United States Public Health Service (Public Health Bulletin No. 220); in this publication the reader will find a very thorough treatment of all phases of milk production from the public health viewpoint, and he should thoroughly familiarize himself with it. Such information will be of inestimable value as a guide toward an effective milk control program.

IV

UNDESIRABLE FLAVORS IN MILK

Milk is a food which readily takes on flavors, and the sanitarian is frequently called upon to assist producers and processors in determining the cause of the trouble. An understanding of the principal causes for abnormal flavors and a knowledge of how to prevent them are of definite advantage to anyone engaged in milk control work. Although real ability to detect flavors and odors in milk is developed in only a few, it is a talent latent in all, and a milk inspection program will reach a higher degree of attainment if the control official trains himself to be an accurate judge of milk flavors.[80]

> The judging of milk for flavor is paralleled in the evaluation of other beverages, such as tea, coffee, and wine, which are also graded for flavor by the organoleptic method. Experienced judges, accustomed to the same standards for flavors, have agreed remarkably in the scoring of a given set of samples. Individuals vary in their ability to detect certain tastes; some, for example, cannot recognize bitterness, because of an inherited failure of their taste organs. Physiologists report that the organs of taste in the mouth can recognize only the sensations of sweetness, bitterness, saltiness, and sourness. Flavors in milk caused by feed, absorbed gases, or products from the deterioration of fat or protein may be detected by the sense of smell alone, especially if the milk is warm.[68]

An "off" flavor affects the commercial value of milk, for the consumer is quick to detect it. Failure to correct the condition promptly will result in loss of business to the dairy and will be a source of persistent public complaint to the health department. Not only is it necessary to identify the cause; it is equally important to establish remedial measures to prevent recurrence.

CAUSES OF UNDESIRABLE FLAVORS

Abnormal flavors in milk are due to a number of causes, some of which are difficult to determine unless one has had training and experience as a judge of dairy products. However, it must be borne in mind that "normal whole milk is pleasantly sweet, possessing neither a foretaste nor aftertaste other than that imparted by the natural

richness of the milk."[80] Obviously, it is necessary to know the taste of normal whole milk before one can judge abnormalities.

Abnormal flavors in milk are due generally to four primary causes: 1) the physical condition of the cow; 2) highly flavored feeds and weeds; 3) odors absorbed by milk during or after production; and 4) biological and chemical changes in the milk.[6] When there are udder disturbances resulting from inflammation of the udder tissues, saltiness is the most common taste defect. Mastitis, which causes milk to increase in chloride content, is another common cause of salty flavor. Milk from animals late in lactation, such as those milked longer than a year, is apt to be salty and to have a rancid flavor. When milk fat is acted upon by the enzyme lipase some of the products of hydrolysis of the fat impart this rancid flavor.

The succulent feeds such as corn silage, alfalfa, sweet clover, soy beans, green alfalfa, cabbage, turnip, rape, and kale seriously affect the flavor and odor of milk; green rye, cowpeas, potatoes, dried beet pulp, and carrots have only a slight effect; green corn, oats and peas, green soy beans, pumpkins, and sugar beets have no effect. Highly flavored feeds should be given to cows *after* they have been milked, never before. Certain pasture weeds impart an undesirable flavor to milk; of these, the worst offenders are wild onion, garlic, alfelaris, stinkweed, and bitterweed. Cows should be removed from pastures infested with such weeds at least five hours before milking is begun; in fact, if possible, such pastures should be avoided altogether.

Odors absorbed by milk during and after production reflect the environment in which the milk is produced. Milk absorbs odors quickly, and gasoline, paint, fly spray, and disinfectants may contribute aromas frequently noted. Milk produced under insanitary conditions in crowded, poorly ventilated stables will absorb an odor usually designated as "barny" or "cowy." If it is allowed to stand in stables where the air is saturated with the odors of manure, urine, and strong feeds, a very noticeable flavor and aroma will result. Fat is the constituent of milk mainly involved in this absorption. Absorbed odors, particularly those caused by a stuffy atmosphere, can generally be removed by aerating the milk over a surface cooler, but the main issue is the avoidance of conditions likely to impart a foreign flavor or odor to milk.

Biological changes are brought about by the action of bacteria,

yeasts, and molds; however, if milk is produced in a sanitary manner and cooled and held at 50° F. or below, the multiplication of flavor-producing organisms is decidedly inhibited. Occasionally it happens that flavors attributable to feed are really of bacterial origin. Souring of milk is, of course, the most common biological change; microorganisms may also give milk a malt-like flavor or a bitter taste. Yeasts and molds also may cause changes, but these do not become significant until milk and cream have been held for a considerable period. Milk may have a flavor sometimes designated as "unclean," leaving an unwholesome aftertaste; this is associated with contaminated utensils and containers.

Chemical changes in milk of greatest importance to the control official are those due to exposure to copper, copper alloys, or sunlight. When such changes take place, the milk may be described as "cappy," "papery," "tallowy," "metallic," or "oxidized." The predominant opinion of nearly all investigators is that milk, particularly when warm, dissolves small amounts of metal which, acting as a catalyst, hastens the oxidation of the milk fat; the products of such oxidation are the source of the substances that cause the flavor. Oxidized flavor in milk is observed more often now than it was before pasteurization became so general; also, since under improved methods of refrigeration milk may be stored longer, more time is allowed for an oxidized flavor to develop. Roadhouse and Henderson[68] are of the opinion that oxidized flavor can be avoided if chrome nickel-iron and chromium-nickel alloys are used in milk-processing equipment rather than brass, bronze, monel metal, and nickel silver. Investigations by Anderson, Dowd, and Struewer,[5] however, seem to indicate that oxidized flavor in milk is associated with the apparent acidity of milk. In the course of their experiments they examined milk from several small commercial plants never troubled with oxidized flavor. Some of this milk was run through a plant where oxidized flavor was giving trouble. The milk from the small commercial plants so processed did not develop an oxidized flavor. These investigators then showed that neutralizing the milk below 0.15 per cent acidity prevented the development of oxidized flavor. Their final conclusion was that milk of high acidity invariably develops an oxidized flavor when pasteurized.

Sunlight imparts an oxidized flavor when bottled milk is exposed to it. This flavor has been noted in milk after a ten-minute exposure to

the direct rays of the sun, and even an exposure to indirect rays for a period of forty-five minutes will cause it. If the customer allows milk to remain on a porch in the sun, oxidized flavor frequently develops. This is therefore a fact to bear in mind when complaints are received from customers that the milk tastes "cappy."

TESTING MILK FOR FLAVOR

When milk is tested for flavor the sample should be collected in a glass milk bottle and sealed. If the sample is from one cow, it should contain milk from each quarter; if the sample is from one producer, or is from a milk plant, be sure that the sample for testing is representative of all the milk being produced or processed. When testing, first warm the milk to a temperature of 90° to 95° F. Notice any peculiar odor as soon as the bottle is opened. Rinse some of the milk about the mouth, especially to the back (reject it, do not swallow it). Agitate the milk and notice if any odor is present. When possible, ask others to taste the sample to help in identifying the flavor. Bear in mind that an "off" flavor may be due to a variety of causes. The following are the more common ones:

Barny or cowy: due to an unclean or poorly ventilated cow stable.

Tallowy, papery, metallic: due to chemical action in the milk caused by exposure to sunlight or contact of the milk with copper or copper alloys.

Cooked (i.e., suggestive of the flavor of boiled milk): due generally to improper pasteurization.

Feedy: due to weeds in the pasture such as wild onion, garlic, mustard, alfelaris, and stinkweed; to alfalfa, sweet clover, ensilage, beet tops, and such green feeds if fed just before milking; or to odors from feeds (such as ensilage) if milk is exposed to them in the stable.

Watery: milk that is low in total solids.

Musty: due to damp, moldy, poorly ventilated storage space; to musty or moldy feed; or to mold growth in the milk.

Rancid, bitter: generally from cows advanced in the lactation period or with udder disturbances.

Salty: also generally associated with cows far along in their lactation period or with udder disturbances.

Foreign: due to the presence of fly spray, paint, tobacco smoke, gasoline, disinfectants, etc., in the environment.

Unclean: this flavor should not be confused with "barny" flavor, caused by absorbed odors. An "unclean" flavor leaves an unclean and

unwholesome aftertaste; it indicates bacterial contamination due to improperly cleaned and sterilized utensils.

As soon as an abnormal flavor is noted, its cause should be eliminated. From the above list of flavors and their causes it will be noted that the following rules of milk production are important:

1. The stables should be well ventilated.
2. The milk should be aerated.
3. Equipment used for milk handling should be free of open seams and rust spots.
4. No roughage should be fed immediately before or during milking. Pasture containing objectionable weeds should not be used for at least five hours before milking, if at all.
5. Milk should be removed immediately from the stable to the milk house; it should not be strained in the barn.
6. Milk from cows with unsound udders should not be used for human consumption. Examine the first stream of milk from each quarter on a fine-mesh screen or with a strip cup.
7. Equipment must be clean, and milk cooling done promptly.

ROPINESS IN MILK

Although ropiness in milk is not associated with flavors, it is a very troublesome condition sometimes encountered and may be included at this point. Due to the action of the causative organism *Bacterium viscosum* and the organisms of the *Escherichia-Aerobacter* group, the infected milk can be drawn out into long threads; in certain instances the material takes on a tough doughy consistency. When one runs a fork or matchstick through milk which is ropy, the material will stretch somewhat as a rubber band. There is a difference between ropy milk and stringy or gargety milk, the latter showing stringiness at the time it is drawn (due to masses of fibrin and leucocytes thrown off by the udder, usually in cases of bovine mastitis). Ropiness generally will not develop until the milk has been held about twelve hours.[36] Organisms causing ropiness often come from surface waters, and outbreaks of ropiness frequently follow the flooding of lands where animals are pastured—the cows' coats become contaminated and the ropy milk organisms are carried into the milk pail. Additional sources of contamination are cooling tanks, wells open to surface contamination, and pools of stagnant water.

Control measures include strict observance of all sanitary points

of production on the farm and keeping cattle off low land or places where they may wade through stagnant water. To locate the source of the trouble, a half-pint sample of each producer's milk should be taken, placed in a clean bottle, and held at a temperature of 60° F. for twelve to thirty-six hours. Samples showing ropiness will be readily discernible, since the cream on the top will adhere to the cap or will stretch in a clinging thread-like mass when a matchstick or wire loop is pulled through. Bacteriological examination is, of course, to be preferred, and plating of samples on agar will disclose the viscous character of the colonies. Direct microscopic examination is also recommended. *Bacterium viscosum* produces a large capsule, demonstrated best in young cultures; in older cultures the capsules from different cells seem to unite and draw out into long threads, and the capsules are then not as definite.[36] Control in the milk plant involves the following factors:

1. Checking the time and temperature of pasteurization—some ropy organisms will survive at 140° F. for twenty minutes.
2. Dismantling and thoroughly cleaning every piece of equipment, particularly pumps, small fittings, and capper heads.
3. Sanitizing, before processing begins, all milk contact surfaces with a chlorine solution of at least 100 p.p.m. Other sanitizing methods can, of course, be used, although chemical treatment is the more common practice.
4. Checking the efficiency of the can-washing operation. Cans are a frequent source of the ropy milk organism.
5. Checking the cleaning and sterilizing of milk bottles.
6. Maintaining a strict equipment-cleaning routine. Ropy milk outbreaks are often persistent, and failure to observe good plant practices will result in a recurrence.

V

THE PASTEURIZATION PROCESS

THE essence of proper pasteurization is the application of heat to milk at a specified temperature for a specified period of time. By methods now commonly employed, milk is heated to a temperature of between 142° and 145° F. (usually 143° F.) and so held for a full thirty-minute period; or, in the case of high-temperature short-time pasteurization, the milk is heated to 160° F. and so held for not less than fifteen seconds. The selection of a time-temperature combination was based upon careful study of the thermal death points of certain bacteria, and the thirty-minute holding period allows a margin of safety to compensate for unforeseen circumstances, both mechanical and human. This relationship is shown by means of a chart (Figure 20) which was published in 1912 by Dr. Charles E. North.[62] In this chart there appears a neutral zone, bounded above by a curve showing the points at which injury to the cream line occurs and bounded below by a curve showing the thermal death points of the tubercle bacillus. The establishment of a standard temperature and time for pasteurization gave first consideration to the tubercle bacillus, it being the pathogen in milk most resistant to heat. Consequently, any margin of safety for pasteurization selected as necessary for the protection of public health must be measured by its distance above the line showing the death points of the tubercle bacillus. The boundary line for creaming properties above the neutral zone, while of less importance, deserves consideration, since it is very desirable that the process be performed, if possible, without seriously damaging the marketability of milk.

In addition to the time-temperature combination, it is necessary to agitate the milk during the entire heating and holding period, so that *every particle of the milk* is properly heated and held. In this connection, the attention of the reader is directed to the following concise definition of pasteurization from the 1939 edition of the United States Public Health Service Milk Ordinance and Code:

> "Pasteurization," "pasteurized," and similar terms shall be taken to refer to the process of heating every particle of milk or milk products

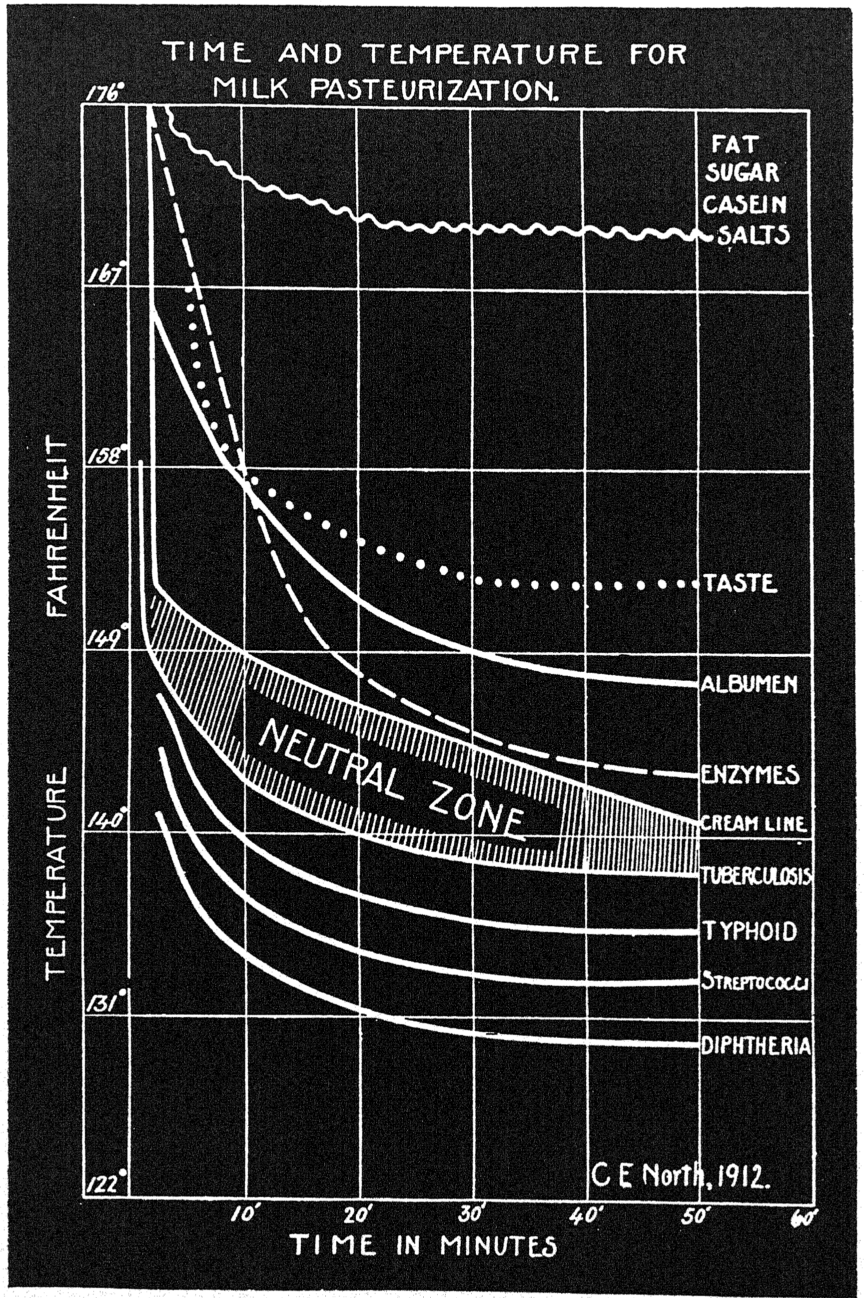


Figure 20. Dr. North's chart of time and temperature for milk pasteurization

> to at least 143° F., and holding at such temperature for at least thirty minutes, or to at least 160° F. and holding at such temperature for at least fifteen seconds, in approved and properly operated equipment; provided, that nothing contained in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient and is approved by the State health authority.[84]

Pasteurization of milk and dairy products must be considered as an important phase of preventive medicine, since it is the surest way the dairy industry has of making its products safe. The case for pasteurization is based on only one point—making milk and dairy products safe. Increasing the use of pasteurized products is a vital step in protecting health and a real contribution to community welfare.

PASTEURIZATION METHODS

The pasteurization processes now most commonly used are the holding method and the high-temperature short-time method. The holding method, as already stated, consists in heating milk in a vat and holding it at a temperature of 143° F. for a full thirty minutes. To facilitate proper heating of every particle of milk, agitators are employed to keep the milk in motion during the entire heating and holding period. The heating medium used is steam or hot water, which circulates in an outer jacket around the vat. Stainless steel or glass-lined vats of modern design are most desirable when the holding method is employed. This process of pasteurization is highly efficient and is recognized and accepted by all milk control officials. Certain safeguards to pasteurization obviously must be employed; these are discussed on pages 117–121.

The high-temperature short-time method of pasteurization, though not as frequently used as the holding method, is rapidly gaining in popularity, especially in plants handling large volumes of milk—the equipment is designed to handle 2,500 or more pounds of milk an hour. (See Appendix page 297 for timing of high-temperature pasteurizers.) This process has not yet been accepted in all parts of the country, some ordinances and laws recognizing only the thirty-minute holding method. The high-temperature short-time method (hereinafter referred to as the high-short process) employs a temperature of 160° F., with the milk held at that temperature for not less than fifteen seconds.

(This should in no way be confused with the unreliable so-called "flash" method which was employed in the earlier days of pasteurization.) In the high-short process, milk is passed through a series of heat transfer plates hung in a frame or press and spaced close together so that thin, wide sheets of milk and heating or cooling medium can flow between the plates. Openings arranged in each plate are matched in adjoining plates to guide milk into each alternate space between rows of plates, with other openings to guide cold milk for regeneration, hot water for heating, or a refrigerant for cooling through intervening plates. In its travel through these plates milk is preheated to a temperature of not less than 160° F., at which temperature it enters the pasteurizing section (generally a stainless steel tube) and flows through at a uniform rate. Not less than fifteen seconds elapse from the time the milk enters the pasteurizing section until it leaves. Automatic control is provided by means of a flow-diversion valve; that is, if milk about to enter the holding section is below the required temperature, it is by-passed by the diversion valve back to the regenerator and cannot pass the valve until the correct temperature has been attained.

The electric (Electro-Pure) method of pasteurization is also a high-temperature short-time process. Here the equipment consists of a plate regenerator section from which milk at a temperature of 133° F. is delivered to an electrode chamber, a vertical compartment through which the milk ascends with a high-velocity swirling motion. Two opposite walls of the chamber are plate glass; the other walls are flat carbon electrodes. As milk flows between the electrodes, electricity passes through it from electrode to electrode. This passage of electricity directly through the milk causes heat to be liberated actually within the milk. A temperature of not less than 162° F. for at least fifteen seconds is employed. From the electrode chamber the milk enters a holding tube, where it is held for at least fifteen seconds. It then goes to the regenerator section, where it is cooled to 69° F. before going to a tubular or cabinet cooler for final cooling to 40° F. or below.

In-the-bottle pasteurization is another process deserving brief mention. It is not commonly used at present, but there is renewed interest in it as a possible solution to the pasteurization of small quantities of milk. It is generally conceded that the purchase and

operation of standard pasteurization equipment are not economical unless the volume of milk handled daily is at least about 300 quarts. Since the small dealer in rural areas may retail quantities much smaller than this, in-the-bottle pasteurization may offer him a solution to the pasteurizing problem. The in-the-bottle pasteurizer operates as follows: Raw milk is placed in a specially designed bottle which provides for one ounce oversize to take care of expansion during the pasteurizing process. The bottle is capped with a crown seal. The filled bottles, in wire cases, are completely submerged for one hour in circulating hot water accurately held at 145° F. by a 10-kilowatt immersion heater. Not only the milk is pasteurized but the bottle and cap as well. There is no handling after the process is completed. Bottles of hot milk are cooled by circulating ice-cold water, and stored until time of delivery. In the cooling process the caps are always held above the water line to prevent water from being sucked into the bottle. Accurate records are kept of each pasteurizing operation by the combination recording thermometer and controller. Not only is the temperature recorded and held at 145° F., plus or minus 1° F., but a small indicator marks the chart at the beginning and end of each period and shows whether or not the lid has been lifted during the process.[73]

Besides the possibilities of the in-the-bottle pasteurizer for the small dealer, another manufacturer* has developed reasonably priced vat pasteurizers in 40-, 80-, and 120-quart sizes. No steam boiler is necessary, since water can be heated by either a side-arm coil gas heater, a laundry stove, or an electric immersion unit.[76]

HOME PASTEURIZATION AND CARE OF MILK

Commercially pasteurized milk is not always available, particularly in small towns and at some vacation centers, and power failure or other accidents may disrupt normal operation of pasteurization plants, so that temporary home pasteurization is sometimes imperative.

It is a relatively simple matter to pasteurize milk in the home if a few simple directions are followed. However, the process should be carried out so that a "cooked" taste will not be imparted nor a surface film formed on the milk. Trout, Devereux, and Bryan[81] have proved

* Oakes and Burger Company, Cattaraugus, New York.

experimentally that a safe, adequately pasteurized milk can be obtained by heating one or two quarts of milk for ten minutes in a covered double boiler containing one quart of vigorously boiling water. It was found that creaming ability was inhibited between 170° and 180° F. and that a "cooked" flavor was noted between 178° and 180° F. Consequently, routine home pasteurization within the 10-degree temperature zone of 170° and 180° F. necessitates the use of a thermometer. The milk should be kept covered during both pasteurization and cooling if film formation is to be avoided.

Milk may be pasteurized in the bottle. The bottled milk is set on a rack in a pail filled with cold water nearly to the level of the top of the bottle. The milk in the bottle is within about an inch of the top. The water in the pail is then heated until a thermometer placed in the bottle of milk registers 145° F. The pail is then removed from the fire and the bottle is left in the hot water for thirty minutes (it is reheated if necessary to maintain the temperature). At the end of the pasteurizing period, cooling is done by gradually replacing the hot water with cold. This method, though effective, is not as rapid as the double-boiler method and there is likelihood of bottle breakage.

A pressure cooker can be used for home pasteurization. Bottles of milk are placed in the cooker and a steam pressure of five pounds is generated after all the air has been expelled from the cooker. The milk should remain in the cooker at least five minutes from the time the gauge reads five pounds.

Each of these three methods will destroy pathogens and will effect a significant reduction in the bacterial content of the milk. Regardless of which method is used, the milk must be cooled as quickly as possible, handled carefully so it is not re-contaminated, and subsequently held at 50° F. or below until used.

The care of milk in the home involves other factors. As already mentioned, milk should not be allowed to remain in the sunlight (on a porch, for example) since an oxidized flavor may develop and, of course, because proper refrigeration is delayed. Milk boxes are commonly provided by dairy companies, and give protection from sunlight and animal contamination at least. Any container into which milk is poured must of course be clean, and milk bottles should be kept capped or covered in the home. When only flat caps are used, both the cap and the lip of the bottle should be rinsed under running

warm water before the bottle is opened. Older milk should not be mixed with fresh milk, and milk bottles should not be wholly submerged in water, since some of the water may be drawn under the cap edge and into the milk. Finally, the householder should be instructed to call the health department if milk showing any abnormality is delivered. Obviously, the home care of milk cannot be neglected, and opportunities should be taken to stress this feature when talks on milk control are given. The care of milk does not stop when the dairy delivers it; it must continue in the home as well.

EXTENT OF PASTEURIZATION IN THE UNITED STATES

The extent of pasteurization in the United States as a whole is a subject of considerable interest to all milk control officials, both from the standpoint of community protection and as a means of judging the effectiveness of milk control effort. In 1923 the United States Public Health Service began to accumulate data on this subject. In 1935–36 it expanded its activities to include inquiry into the milk supply of all communities with populations of 1,000 and over. The final compilation showed that 74.7 per cent of the milk supplies of all communities studied was pasteurized, but undoubtedly this figure is higher now, since several large cities have passed compulsory pasteurization ordinances. The data for 1936, by population groups and geographic divisions, are set forth in Table VII.

A study of this table discloses that the percentage of pasteurization was lowest in communities with populations between 1,000 and 10,000, and that as the size of the community increases the percentage of pasteurization increases. These figures again add evidence to the fact already emphasized that the hazard of milk-borne disease is greater in small communities than in large ones because the percentage of pasteurized milk is lower in small communities.

MEETING COMMON OBJECTIONS TO PASTEURIZATION

Lack of understanding of the pasteurization process and misinformation concerning it are the basis for certain objections; other prejudices are largely emotional. In 1937 the Bureau of Milk Sanitation of the New York State Department of Health published a bulletin, revised in 1945,[34] containing seventeen commonly propounded arguments against pasteurization, with corresponding answers to

Table VII. Percentage of total milk supply protected by pasteurization, by population of cities and by geographic division, and number of cities with specified percentages of milk supply pasteurized*

(Cities of 1,000 population and over in the United States in 1936)

Population group	No. of cities reporting	Percentage of milk supply pasteurized
1,000–2,499	945	24.5
2,500–4,999	470	41.1
5,000–9,999	351	49.4
10,000–24,999	281	58.2
25,000–99,999	169	72.6
100,000–499,999	65	85.9
500,000 and over	10	97.5
Unweighted mean	2,291	41.5
Weighted means:[1]		
Over 1,000		74.7
1,000–10,000		39.3
Over 10,000		83.1

Geographic division	Percentage of milk supply pasteurized
New England	50.4
Middle Atlantic	70.0
East North Central	54.2
West North Central	23.3
South Atlantic	25.3
East South Central	27.0
West South Central	28.1
Mountain	26.7
Pacific	51.3

Percentage of milk supply pasteurized	Cities: *Number*	Cities: *Per cent*
0	742	32.4
0.1–9	58	2.5
10–19	109	4.8
20–29	140	6.1
30–39	105	4.6
40–49	108	4.7
50–59	206	9.0
60–69	153	6.7
70–79	168	7.3
80–89	108	4.7
90–99	259	11.3
100	135	5.9
Total	2,291	100.0

* Adapted from Fuchs, A. W., and Frank, L. C.[32]

[1] The weighted mean for all municipalities of over 1,000 population in the United States was computed as follows: (1) Multiply the percentage pasteurized in each population group by the total United States population in that group and by the per capita consumption in that group; (2) total these products for all groups; (3) multiply the total United States population in each group by the per capita consumption in that group; (4) total these products for all groups; and (5) divide (2) by (4).

The weighted mean for all municipalities of 1,000 to 10,000 population in the United States and that for all municipalities of over 10,000 were computed in the same manner, but only the respective population groups were included.

All other means in this table, including those for each population group and each geographic division, are unweighted.

refute them. Since space does not permit printing the complete answers to the objections, they are given here, somewhat abbreviated and paraphrased, to assist those who must defend the benefits of pasteurization:

Argument No. 1: Pasteurized milk has a "cooked taste."

Answer: The "cooked taste," when it occurs, is due to overheating. Blindfold tests show that groups of people cannot distinguish between raw and pasteurized milk; when all the samples being judged are pasteurized, opinions are about evenly divided as to whether the milk is pasteurized or raw. While the "cooked taste" may be objectionable to some people, it is better to have the milk overheated than underheated. With modern equipment correctly operated by competent persons, pasteurized milk rarely has a "cooked taste."

Argument No. 2: Pasteurization reduces the "cream line" or "cream volume."

Answer: Investigators have found that the volume of cream rising to the surface on a bottle of milk, or so-called "cream line," is not materially affected by heating to temperatures below 145° for thirty minutes. If temperatures rise above those prescribed, as they occasionally do, a slight reduction in the cream line may occur. Obviously this does not mean that any cream has been taken out of the milk, but rather that some of the cream does not rise to the top. Nowadays a considerable volume of homogenized milk is sold, in which case the fat is dispersed throughout the milk and the cream line no longer has significance.

Argument No. 3: In raw milk the vitamins are intact.

Answer: The inference here is that vitamins are destroyed by pasteurization and if this were so it would be important in infant feeding. The fact is that of the several vitamins present in milk only one, Vitamin C, which prevents scurvy, may be reduced in quantity. However, this vitamin, even in raw milk, is of small and uncertain quantity, so milk alone cannot be depended upon to supply it. Vitamin C is present in larger and more certain quantities in orange juice and other fruit or vegetable juices which are now generally used in connection with infant feeding.

Argument No. 4: Pasteurization takes the "life" out of milk.

Answer: Evidence is very meager that enzymes in milk add anything to its food value. Furthermore, studies made by careful workers indicate that enzymes are not destroyed until temperatures of over 144° F. for thirty minutes are employed. (Recent evidence shows that the phosphatase enzyme is destroyed by pasteurization, but evidence is lacking that the presence of this enzyme adds anything to the food value of

milk.) Milk is no more devitalized by heating than is the case when meat, vegetables, or cereals are cooked.

Argument No. 5: Children and invalids "do better" on raw milk than on pasteurized.

Answer: Careful studies prove that there is no significant difference between the growth-promoting capacity of raw and pasteurized milk. In 1932, Leslie C. Frank,[30] of the United States Public Health Service, reported the results of a survey among children and came to the conclusion that children who are fed pasteurized milk or other heated milk thrive as well as children who are fed raw milk, and contract certain communicable diseases less frequently. This study was based on the diet of 3,700 white children of ten months to six years of age.

Argument No. 6: The mineral content of milk may be reduced by pasteurization.

Answer: Mattick and Hallett, reporting on the "Effect of Heat on Milk" in the *Journal of Agricultural Science* in 1929, found that the total amounts of calcium, phosphorus and nitrogen in milk could not be altered by the application of heat, although it is probable that some change in the solubility of one or more of their salts may be effected. About 2 per cent of the total calcium becomes indiffusible, which is a negligible amount as milk is only one of several sources of calcium salts.

Argument No. 7: Cooked milk is likely to be constipating.

Answer: First of all, pasteurized milk is not "cooked milk." The prescribed temperatures are far below the boiling point. Pasteurized milk is no more likely to be constipating than raw milk. In fact many pediatricians frequently prescribe boiled milk for babies and no difficulty from constipation is experienced.

Argument No. 8: There are certain physicians who recommend raw milk for babies in preference to pasteurized.

Answer: The four preceding arguments having been answered, little more needs to be said in answer to this argument. Universal agreement on a matter of this kind would be too much to expect. A few years ago a questionnaire was sent to a number of the most prominent pediatricians in the country asking whether they preferred pasteurized or raw milk for infant feeding. Only a very small minority favored raw milk. Improved methods and proper pasteurization leave no opportunity for criticism of the process on the part of practitioners of medicine or of the laity.

Argument No. 9: Pasteurization is an excuse for the sale of dirty milk.

Answer: There was a time, years ago, when this probably was true in many instances. However, where active milk control is in effect definite standards of sanitary quality for milk previous to pasteurization are

prescribed with a routine testing and farm inspection program carried on. In fact, standards of cleanliness among dairymen and milk dealers are much higher today than was the case in earlier days. Furthermore, while dirty milk, whether raw or pasteurized, should not be tolerated, even such milk if effectively pasteurized is safer so far as the dissemination of communicable diseases is concerned than the general run of raw milk.

Argument No. 10: Pasteurization may be carelessly done. It is therefore not infallible.

Answer: Obviously it is true that either raw or pasteurized milk may be carelessly handled. Dr. M. J. Rosenau[70] refutes this argument very effectively with this statement: "Pasteurization is not an ideal—it is an expedient, and if you could ever get the milk industry to such a point that cows would always be in perfect health and where there would be no added infection in handling and in transit—then pasteurization would no longer be necessary. But I cannot see that that day will ever come, certainly not in your lifetime or in mine, and in the meantime we must adopt pasteurization to make milk safe, just as we purify water and certain of our other foods."

Argument No. 11: Pasteurization destroys the souring bacteria so that milk instead of souring normally will putrefy if kept long enough.

Answer: Fortunately, pasteurization does destroy many but not all of the "souring" bacteria, most of which get into the milk with dirt, and this accounts for the fact that pasteurized milk usually keeps longer than raw milk. Few people are likely to worry because their milk keeps sweet too long. Not all these bacteria are destroyed and the milk does sour "normally" but usually somewhat less quickly than raw milk.

Argument No. 12: The toxins formed by disease bacteria may not be destroyed by pasteurization, or possibly dangerous substances might be formed by destruction of other bacteria.

Answer: There is a question whether the toxins formed by virulent hemolytic streptococci would be destroyed or rendered innocuous by pasteurization. [It has been shown that an enterotoxin produced by the excessive growth of staphylococci is not destroyed by pasteurization.] Dr. Ruth Gilbert of the Division of Laboratories and Research says, however: "One would not expect serious illness to result from the preformed toxins that might be in the milk if living bacteria were not present. Thus, as far as experience and the literature would indicate, hemolytic streptococci in milk are a menace only in case the organisms are alive, the symptoms resulting from ingestion being due to infections rather than toxemias."

Argument No. 13: Pasteurization is unnecessary in "the country" where milk goes directly and promptly from producer to consumer.

Answer: This argument is based upon a popular impression which experience has proved to be entirely fallacious. It is, of course, desirable that milk be fresh, but the slight delay incident to shipping it a reasonable distance and pasteurizing it is a matter of little moment, providing that it is good milk to start with, is kept cold, and is otherwise properly handled. A more important consideration is that of the transmission of infection. Records of milk-borne disease indicate that the majority of them occur in small communities where little, if any, of the milk supply is pasteurized. The fact that the source of supply is close to the source of consumption makes no difference if the milk is infected with disease organisms. Evidence is incontestable that the small town dweller using raw milk from a local dairy runs a greater risk of infection than does the city dweller who enjoys the protection afforded by pasteurization.

Argument No. 14: Pasteurization will increase the price of milk.

Answer: In these days people buy insurance against all sorts of contingencies: death, accident, sickness, fire, etc. The consumer who pays the additional cent or two a quart for efficiently pasteurized milk is buying cheap and effective insurance against milk-borne infection.

To people in moderate or poor circumstances, particularly when they have large families, even the addition of a few cents a week is an important consideration. However, if their families happen to be among the victims of milk-borne infection the cost to them in a period of a few *weeks* probably will vastly exceed the additional cost incident to obtaining pasteurized milk over an equal number of *years*. Even conceding that their chances of becoming infected are relatively small, this is still an important consideration.

Argument No. 15: There are always some people who "demand raw milk."

Answer: Many people who demand raw milk do so because they have not taken the trouble to inform themselves on the relative virtues of raw and pasteurized milk or because they have been misinformed. The person who contracts a disease like typhoid or scarlet fever from milk becomes a potential source of danger to others. A milk-borne epidemic in any community hurts business and injures the community. In order that the safety and interests of the community as a whole may be protected, local authorities are wisely given power to enact such ordinances or regulations as may be necessary for the protection of public health. In exerting such authority they rarely act unreasonably or arbitrarily. In certain places the demand for raw milk has been met by permitting the sale of certified milk, a raw milk selling for a comparatively high price because of the extreme precautions taken to make it the safest possible raw milk. This may be a reasonable compromise. Experience has shown, however, that on innumerable occasions persons insisting on raw milk

have been surprised to learn that they have been using for some time pasteurized milk labeled with a raw milk cap, and had not known the difference.

Argument No. 16: If pasteurization is required many small raw milk dealers will either have to go to the expense of buying pasteurizing apparatus or go out of business.

Answer: All business to survive and to prosper must constantly observe the trend of the times, keep up with the march of progress, and be prepared to meet new competition. In the world of business certain individuals fail to do this and fall by the way. The progressive man expects changes and prepares to meet them. Furthermore, the financial interests of any individual or group cannot properly be weighed against the protection of the community as a whole.

Argument No. 17: In rural communities the quantities of milk sold are so small that pasteurization is impracticable.

Answer: So far as the sparsely settled rural community is concerned this argument comes nearer to being valid than any of the other sixteen. The overhead cost of pasteurizing less than about two hundred quarts is relatively high. The answer, however, is fairly obvious. In these days of motor transportation most communities are near enough to larger centers so that they can easily be reached by dealers who pasteurize. These dealers will come in if there is sufficient business to warrant. Most people like to patronize home industry, but one must remember that in recent years good roads, the automobile and the telephone have pushed back boundary lines so that "home" now covers a much larger area than it did in the past. There is yet another point: the dealer who cannot afford to pasteurize frequently cannot (or thinks he cannot) afford to take other necessary precautions in the handling of his milk. He should not expect to set the pace for his community.

These arguments sum up very well the type of objections with which the sanitarian will generally be faced when he seeks to further pasteurization. Although opposition to pasteurization is, fortunately, dwindling, in some communities any movement to disturb the status quo will engender aggressive opposition, and it is wise to be ready with rational answers based upon scientific fact.

VI

PLANS FOR THE MODERN PASTEURIZATION PLANT

If a pasteurization plant is to be operated profitably, it must be intelligently laid out and equipped with modern facilities. Regardless of size, it must be planned for getting the most out of both labor and machinery; it must be sanitary and so designed that it can be kept sanitary; and it must embody up-to-date safeguards in conformity with local or state milk regulations.[17]

STUDY OF PLANS

Most sanitarians with field experience have been called upon by milk dealers to pass judgment on plans either for remodeling or enlarging an existing plant or for constructing a new one. This is the ideal time to recommend improvements.

Plans for remodeling or enlarging

If the plans are for remodeling or enlarging, the sanitarian should check them carefully against each provision of the local milk ordinance, bearing in mind defects in the existing plant and developing or approving suggestions for correcting them. In order that each condition may be intelligently considered, it is suggested that the sanitarian use a check list somewhat as follows:

Does the proposed remodeling or enlargement improve sanitation in the following respects:

1. Supply ample floor drains and provide for proper slope of floor?
2. Meet ordinance specifications for interior finish for walls, ceilings, and partitions?
3. Provide ample natural and artificial lighting, properly located to facilitate operations?
4. Provide ample space for new equipment if such is to be purchased? (Ample space aids efficiency and makes cleaning easier.)
5. Provide rooms of sufficient size for separation of processes and for storage?
6. Provide adequate, properly located toilet and washroom facilities?
7. Eliminate plumbing defects such as submerged inlets and direct pipe connections between potable and unsafe water supplies and waste lines?

8. Provide openings for efficient loading and unloading operations but with adequate protection against the entrance of flies?
9. Eliminate all major defects of the existing plant?

In addition to these points the plans should also provide for possible increase in business. It is obvious that the sanitarian and the pasteurizing plant owner will discuss any plans of this nature in detail. Special conditions sometimes make compromise necessary, but all details of sanitary significance should be made to conform to accepted sanitary practice and to meet ordinance requirements.

Plans for new building

In the event an entirely new plant is to be built, the sanitarian may be called upon for advice and suggestions from an architect or a designer, or the plant owner may submit his own rough sketch of his proposed plant. In such instances, health department plant specifications should be available to serve as a guide for layout and construction. Specifications for new dairy plant construction are given herewith:[43, 86]

General Instructions

1. Plans shall be approved before construction begins. Plans shall be submitted in duplicate so that an approved copy may be returned to the applicant and an approved copy kept on file in the office of the Health Department. The plans shall give the name and address of the applicant submitting the plans, the name of the architect or engineer preparing the plans, the date of preparation, north compass point and a number or designation for each sheet.

2. The proper local and state officials should be consulted as to regulations and requirements concerning zoning, building materials, plumbing, power, heat, light, ventilation, fire protection, and all other items involved in new construction or in alterations.

3. Prepare a plot plan using the scale of one inch equals 20 feet or one inch equals 40 feet. Cross-section paper may be used. Show the location of all buildings on the plot, entrances to buildings, driveways, surface drainage and sewer connections.

4. Prepare a floor plan using a scale of one-quarter inch equals one foot except for buildings approaching 100 feet, when a scale of one-eighth inch equals one foot may be used. The floor plan shall show the location of partitions, doors, windows, ventilators, skylights, drains, sewer lines, and plant equipment. Also give an elevation sketch including floor elevations above and below finished grade.

5. If any part of the building used as a milk plant is used for domestic purposes, that part of the building so used shall not have a passageway that connects with the milk plant.

Construction

1. Building must have a minimum floor area of 800 square feet with a minimum ceiling height of 8 feet.

2. Exterior walls must be of at least 8-inch thickness of brick, hollow tile, cement block with weather-resistant exterior finish, cinder block, plastered or stuccoed, smooth surface concrete, or other equivalent materials.

3. Window area must be one-eighth of floor area, with provision for ventilation. One 60-watt electric light for each 100 square feet of floor space shall be provided.

4. Floors must be constructed of concrete or other equally impervious and easily cleaned material and shall be sloped not less than one-eighth inch per foot to drains, and drains shall be properly trapped in accordance with city plumbing code. Walls and floor joints must be coved or rounded. Floor brick or iron plates shall be provided for parts of floor subject to excessive wear by trucks or rolling cans.

5. Ceilings in rooms in which there is steam vapor must be metal lath with three-quarters of an inch thickness of Portland cement plaster; this plastered ceiling to be painted with "Bondex" or other approved waterproof sealer and finished with a light color enamel paint which is moisture repellent and washable.

6. Boiler room must be separated from the rest of the building by an 8-inch masonry wall with a door leading directly to outdoors. All doors from boiler room must be metal clad and equipped with an automatic door check device.

7. Interior walls other than boiler room shall be made of either tile, brick, smooth surface concrete or cement plaster with coved or rounded floor joints. Windows in such walls may have either wood or steel sash, but steel is recommended. "Keen" cement finish or other approved material is recommended for walls.

8. Ventilation equipment supplementary to doors and windows is to be provided if necessary.

9. All openings to the outer air shall be effectively screened during the fly season. All doors shall open outward and be self-closing.

Location of Operations and Rooms[27]

Separate rooms must be provided as follows:

1. Receiving room. Dump tank must be equipped so milk can be pumped to holding tank or pasteurizer; can washing may be done in this room.

2. Room for pasteurizing and other processing.

3. Cooler-bottling room, unless cooler is equipped with approved metal cover.

4. Washrooms for washing of bottles, cans, containers, utensils, and equipment.

5. Storage room. If caps are stored in room with other supplies they must be in cupboards with tight-fitting doors.

6. Boiler room.

7. Toilet room with ample hand-washing facilities therein or adjacent. The toilet room shall not open directly into any processing room.

8. Office.

9. Cold storage.

Equipment[27]

1. All equipment must have enough clear space on all sides to be easily accessible. The pasteurizers must have at least a 5-foot aisle in front and at least a 2-foot aisle in rear and on sides, with an electric light so situated that the interior is easily visible.

2. The cooler must have at least 3 feet of clear space on each side and 2 feet on each end.

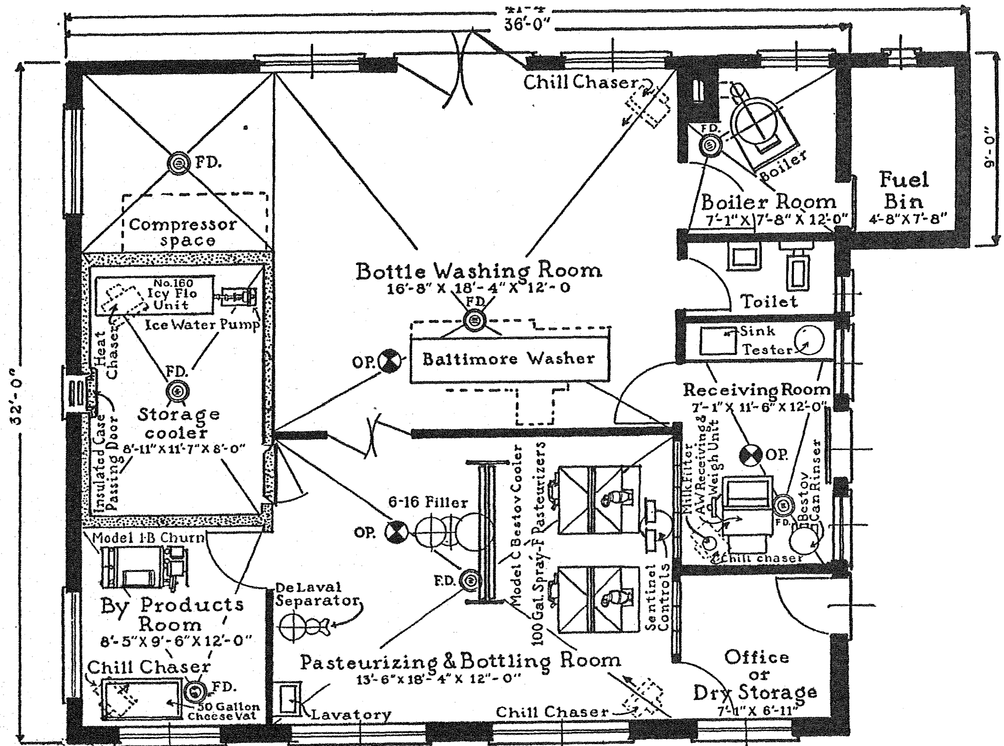
3. A metal wash tank must be provided for washing of pipes and fittings. A rack to hold the cleaned pipes must be provided.

SUBMISSION OF PLANS

Plant specifications, as well as all other plans for equipment arrangement and so forth, should be checked against those which are basically standard in nature, or against model plans which have been developed by dairy plant or sanitary engineers. Size of plant or size of rooms obviously cannot be standard because of variations in volume of business and varying sizes and types of milk equipment. Model plans at best serve only as a guide, for each plant design presents its individual problem. Two designs are, however, shown because they typify layouts for small and medium-sized plants (Figures 21 and 22). There are points about each to assist a sanitarian in making suggestions to plant owners when plans are being examined for approval.

Furthermore, every milk ordinance should include a provision requiring that plans for construction or extensive remodeling of any plant be submitted to the health department for approval before work is begun. Such a provision, quoted herewith, is a part of the United States Public Health Service Milk Ordinance and Code:[34]

All dairies and milk plants from which milk or milk products are supplied to the city of ____________ which are hereafter constructed, re-

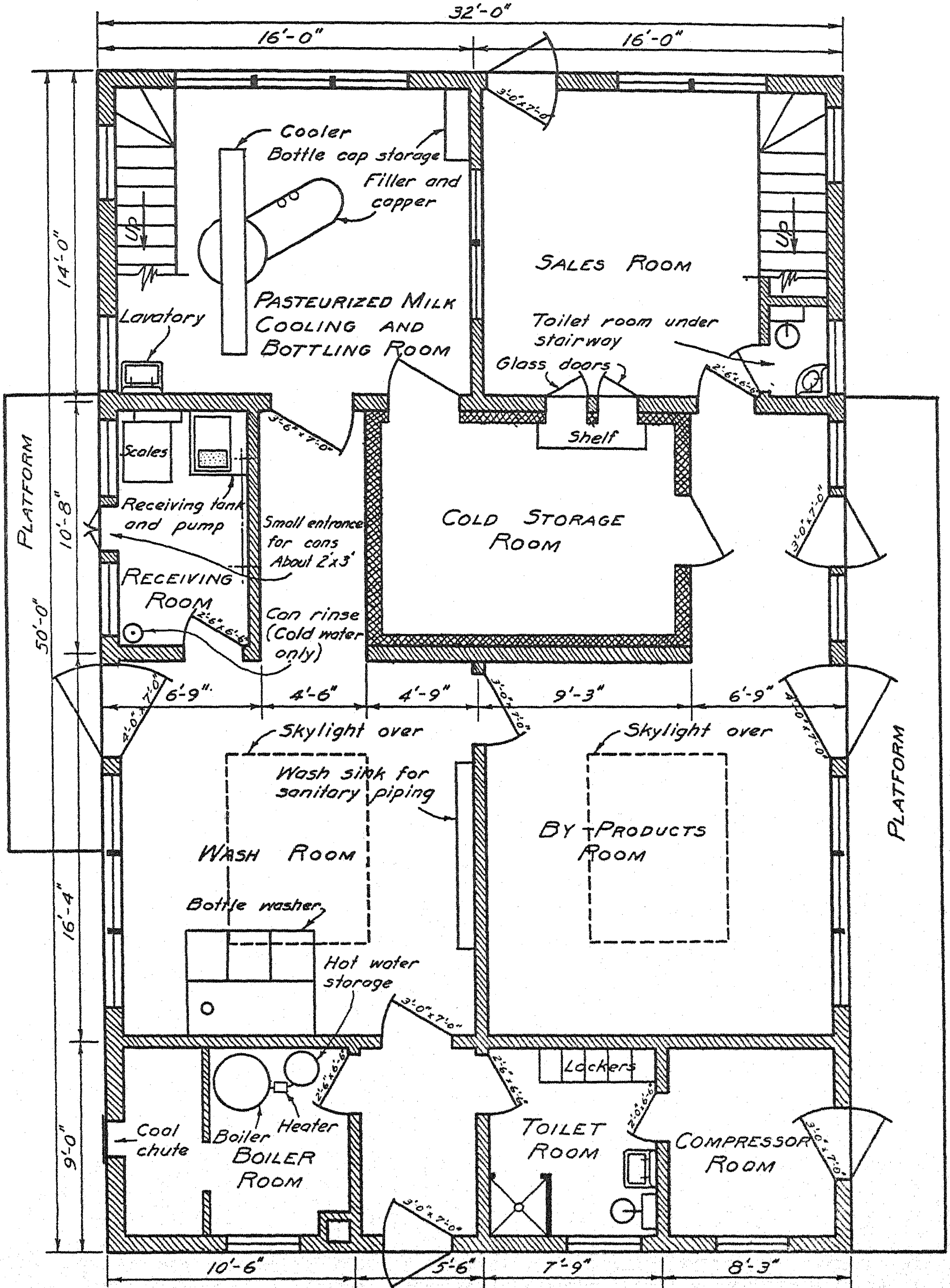


Courtesy Cherry-Burrell Corp., Chicago

Figure 21. Plan for a small milk pasteurization plant

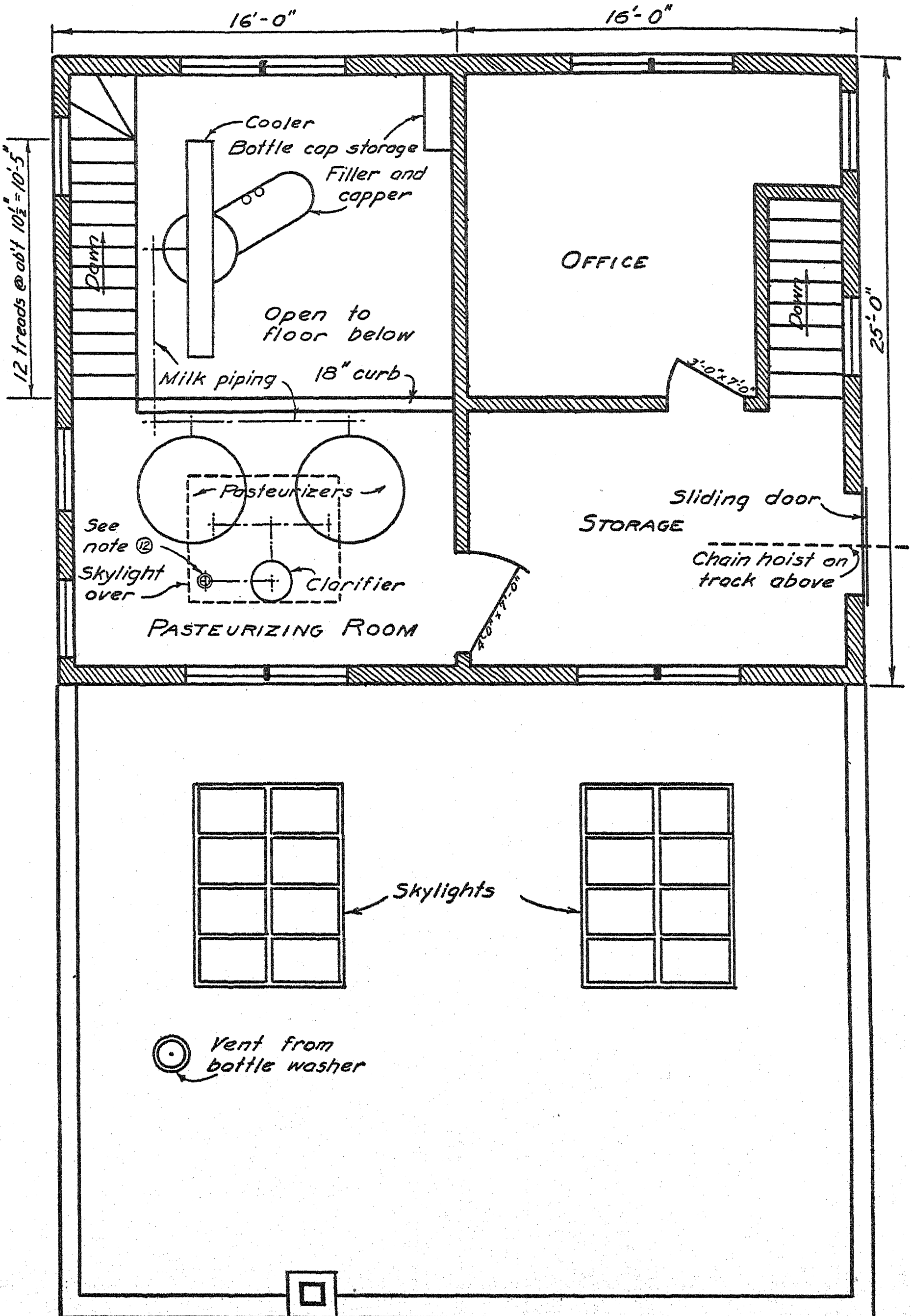
Notes on Figure 22

1. Floors shall be of concrete, tile, or other impervious material and shall slope to trapped drains at the rate of about 1/4 inch per foot. Drains should be located at the ends of rounded gutters running along the base of the walls. Floors should slope from the center of a room toward these gutters. This method of floor drainage will insure a dry floor in the center of a room, which is the most traveled portion.
2. Walls and ceilings should be finished with tile or hard Portland cement plaster. (Valuable information on concrete and cement plaster may be obtained from the Portland Cement Association, 33 West Grand Ave., Chicago, Ill.)
3. All openings into the outer air shall be screened with 16-mesh wire screening to prevent the entrance of flies. Screen doors must open outward. All doors must be self-closing.
4. Powerful fans should be installed at the outside entrances to the receiving room, wash room, and loading vestibule. These fans should be operated so as to prevent the entrance of flies while these entrances are being used.
5. Separate equipment must be provided for the handling of sour milk products.
6. All milk piping must be at least 1½ inches in size.
7. Equipment must conform to the specifications of the United States Public Health Service Milk Ordinance and Code.
8. Refrigeration equipment should be selected before construction of cold storage and compressor rooms is begun.
9. Joints between floor and wall should be rounded to a radius of about one inch.
10. Floors should be reinforced with metal grid plates at points of hardest service, especially in the receiving and cold storage rooms and in the loading vestibule.
11. The milk pipe line from the receiving room must be brought through the floor of the pasteurizing room in such a way that floor drainage will not drip down through the opening and contaminate equipment in the receiving room below. A piece of 4-inch cast iron pipe cast in the floor and projecting about 12 inches above the pasteurizing room floor is a good conduit.
12. The clarifier must be connected to the pasteurizers by sanitary milk piping and connections.
13. Stairway treads are about 10½ inches, risers are 8 inches. Sixteen risers at 8 inches equals 128 inches, equals 10 feet 8 inches floor to floor.
14. The use of pivoted or projected steel windows is urged.
15. All skylights must be equipped with ventilators.
16. All milk-handling rooms must be provided with an adequate number of water and steam outlets.



Courtesy North Carolina Dept. of Health

Figure 22a. Plan for a medium-sized pasteurization plant—First floor



Courtesy North Carolina Dept. of Health

Figure 22b. Plan for a medium-sized pasteurization plant—Mezzanine floor

> constructed, or extensively altered shall conform in their construction to the requirements of this ordinance for grade A dairy farms producing milk for consumption in the raw state, or for grade A pasteurization plants, respectively: Provided, that the requirement of a two-room milk house shall be waived in the case of dairies the milk from which is to be pasteurized. Properly prepared plans for all dairies and milk plants which are hereafter constructed, reconstructed, or extensively altered shall be submitted to the health officer for approval before work is begun. In the case of milk plants, signed approval shall be obtained from the health officer and/or the State Health Department.

In this chapter a brief summary has been given of the points to be considered when milk plants are being constructed or remodeled. It is highly desirable that all plant owners and operators be aware of any ordinance provision requiring approval of plans by the health department, so that mistakes in layout or construction can be avoided.

VII

PASTEURIZATION PLANT EQUIPMENT AND INSPECTION

In order to make effective inspections of pasteurization plants, the sanitarian must understand the basic principles by which equipment operates. He must know equipment sufficiently well so that those parts which are most likely to influence the sanitary quality and safety of milk can be critically and carefully inspected. He must be able to follow the flow of milk through the equipment and understand the part each piece of equipment plays in the whole processing scheme. In plants of modern design the milk, upon reaching the plant, passes through equipment usually in the following manner:

1. *From cans to tanks.* Milk is dumped from cans into the weigh tank, thence to the dump tank. (The can washer is located in the receiving room: empty cans are placed in it for washing and the cleaned cans returned to the hauler.)
2. *Through cold milk filter or clarifier to pasteurizing vats.* When the milk leaves the dump tank it flows, generally by gravity, to the milk pump. The pump forces milk through a filter, from which point it is forced by the pump through sanitary piping to a holding or storage tank or directly to pasteurization vats. In some plants a clarifier may be used in place of a milk filter.
3. *From pasteurization vats to homogenizer and then to cooler.* After pasteurization, milk flows through the vat outlet valve to a milk pump, where it may be forced through sanitary piping to a homogenizer and then to the cooler; or it may go directly from the pump to the cooler. In some installations milk goes through a preheater or may go from a regenerative section to the homogenizer before going to a pasteurizer.
4. *From cooler to bottler, to bottles, and to cold storage room.* After flowing downward over the cooler, where it collects in the bottom cooler trough, the milk flows, generally by gravity, to the bottle-filler. From the bottle-filler bowl it flows through tubes to the bottles. The bottles are mechanically capped, placed in cases, and conveyed to the cold storage room.

Following this order of milk flow, a general discussion of the principal equipment used, certain of its features, and the main points of inspection to be observed is given herewith.

*RECEIVING ROOM EQUIPMENT**

THE WEIGH TANK (Figure 23, top)

This is generally a square or rectangular tank suspended by rods and connected to a scale. In small plants, the tank may be cylindrical and set directly on a small platform scale. The milk is dumped from cans into this tank and the weight of the milk recorded. Weigh tanks are constructed of tinned copper or stainless steel. The bottom of the tank slopes toward an outlet valve, which is generally of the lift or disc type, 8 to 12 inches in diameter. The operator opens and closes the valve by means of a rod attached to it.

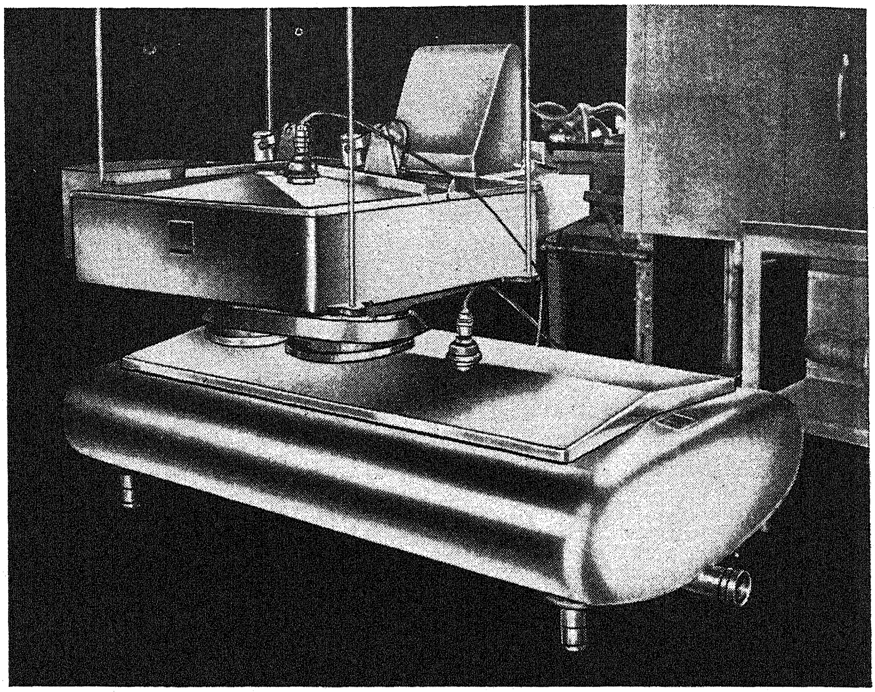
Inspection points. The weigh tank should be fitted with a cover whose edges extend over and downward from the outer edges of the tank. The milk is poured through an opening in the cover. This opening should be covered whenever the tank is not in use or during any period of interruption in dumping operations. Only perforated metal strainers should be permitted in the opening; wire mesh strainers are not permitted because they cannot be readily cleaned. The interior of the tank must be smooth and easily cleaned. The supports by which the tank is suspended and the underside of the tank must be clean. The tank itself must be in good repair and preferably seamless; if it isn't seamless, all seams should be flush. The outlet valve closure should be of the disc type and removable for cleaning.

THE DUMP TANK (Figure 23, bottom)

This tank is somewhat similar to the weigh tank in construction except that it is generally larger, is not suspended from a scale, and has a ferruled outlet opening to which sanitary piping can be attached. It is also of stainless steel or tinned copper. The dump tank should have a cover which has openings to match the outlet valve openings in the weigh tank. All openings in the cover should have raised edges to prevent moisture or possible contamination on the cover from falling into the milk.

Inspection points. The interior and cover of the tank must be in good repair and easily cleaned. The cover must fit properly. Inspection for cleanliness and repair is a major consideration.

* This equipment is not usually provided in small country plants. Since the volume of milk handled is small, the milk is dumped directly from the cans into the pasteurizing vats. Also, milk may be produced and pasteurized on the same farm. In general, however, the point is to avoid unloading cans of milk directly into the pasteurizing room.



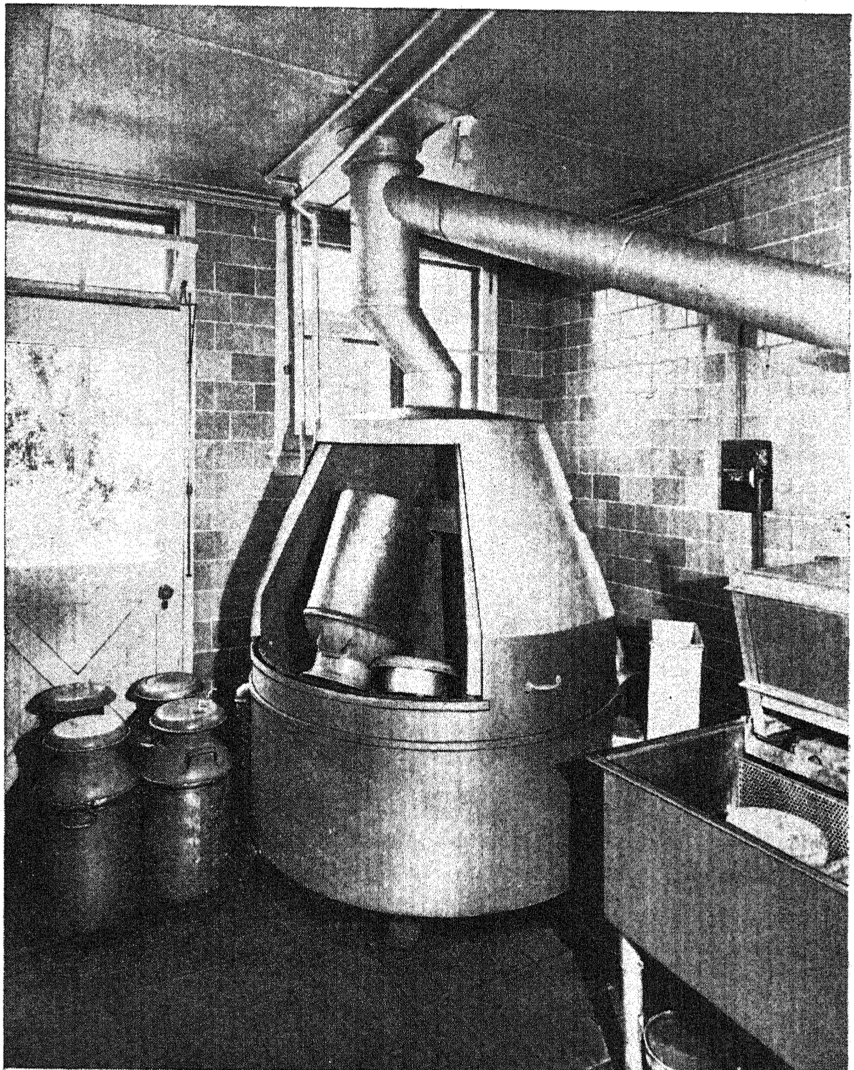
Courtesy Rice & Adams Corp., Buffalo

Figure 23. Standard stainless steel weigh and dump tank assembly

THE CAN WASHER*

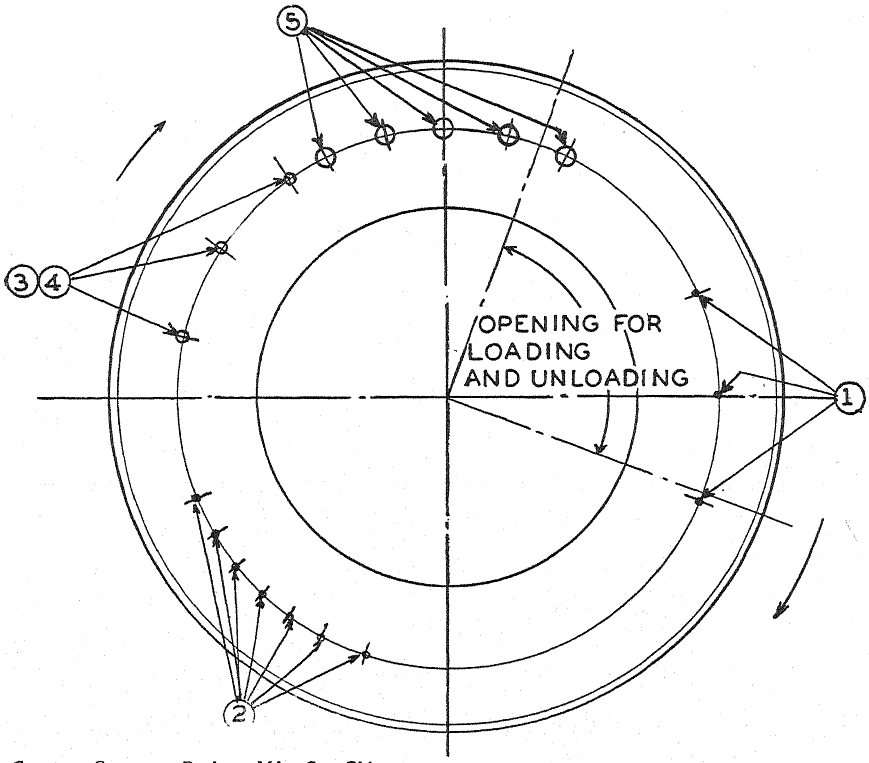
Mechanical can washers are usually of the rotary or straight-away type. The empty cans are inverted and placed in the washer, where they revolve on a turntable, divided into compartments; each compartment holds one can and cover. The turntable revolves continually while the machine is operating, carrying the can over various jets which wash both inside and outside. The drive is generally intermittent with a timed speed, and automatic so that the operator cannot hasten the operation over its rated capacity.[50] In the straight-away washer, cans and covers are conveyed in a straight line through the entire length of the machine, passing over various rinsing, washing, and sterilizing jets. In both types of washer the principles of can cleaning are about the same. The rotary washer (see Figures 24 and 25) is generally used in small and medium-sized plants and the straight-away type in larger plants.

* In small plants can washing is usually done by hand.



Courtesy Creamery Package Mfg. Co., Chicago

Figure 24. Rotary can-washer installation commonly used in the milk plant



Courtesy Creamery Package Mfg. Co., Chicago

Figure 25. Diagram showing order of can treatment in a rotary washer capable of handling three milk cans and covers a minute

KEY TO OPERATIONS:

1. Pre-rinse—2.5 seconds
2. Solution wash—18 seconds
3. Sterile rinse—3.5 seconds
4. Steam sterilize—3.5 seconds
5. Hot-air drying—16.4 seconds

Inspection points. The real test of can-washing efficiency is the cleanliness of the washed can. Inspection of the can washer is not as easy as inspection of some other milk plant equipment. However, because the washing and cleansing of milk cans have such an important bearing upon the bacterial quality of raw milk, much attention must be focused on the process. Cans should emerge from the washer clean, dry, and at a temperature sufficiently high to assure bactericidal action. When inspection of cans coming from the machine shows unsatisfactory results, one or more of the following factors may be responsible:

1. The pre-rinse or the solution wash jets may be plugged, or the pressure of water going to the pre-rinse jets may be too low.
2. The operator may not be adding sufficient washing powder to the solution tank at the beginning of the operation or during it. (Most manufacturers of detergents issue instructions specifying the amount of cleaner to be added for different types of machines. Sometimes automatic solution feeds are used.)
3. The pipe leading from the centrifugal pump to the solution wash jets may be badly scaled, reducing the force of the spray entering the cans.
4. There may be insufficient steam pressure to insure complete steaming of cans.
5. Mechanical difficulty may be experienced because of worn parts.

More precise than visual inspection is the following method of evaluating can-washing efficiency: rinse cleaned cans with 100 ml. of sterile water and plate 1.0 ml. and 0.1 ml. portions of the sample on nutrient agar; the bacterial content should not exceed 40,000 colonies per 40-quart can. (For complete procedure, see the American Public Health Association's Standard Methods for the Examination of Dairy Products, 8th ed., 1941, pages 131–132.)

SANITARY MILK PIPING

Sanitary milk piping is of tinned copper, stainless steel, or Pyrex glass.* It must be constructed of a durable material that gives a smooth, easily cleaned surface. Sanitary piping is regularly supplied in 1½-inch, 2-inch, 2½-inch, 3-inch, and 4-inch sizes. Valves and numerous fittings are used for connecting pipe lines to the several

* Glass piping has been found successful as a substitute for metal piping, although its present use is limited.

pieces of milk plant equipment. Within the past few years a method has been developed eliminating the use of solder for connecting ferrules and fittings to stainless steel pipes. This has become known as recessless piping and is of great advantage from the sanitary viewpoint. Instead of soldering fittings and ferrules to lengths of pipe, tending to cause burrs and loose open joints where pipe and fittings meet, the fitting or ferrule is placed over an end of the stainless steel pipe at the desired point and held firmly in a special vise. Then an expander is inserted and the pipe expanded into the fitting under considerable pressure, forming a tight connection. A simple facing and polishing device which fits any standard racket-type hand brace is then used to remove any saw marks or burrs so that the pipe and fitting will be smoothly faced. Although recessless piping is not in use in all plants, it should be specified as highly desirable when replacements are made.

Inspection points. Since milk passes almost continuously through piping from the time it reaches a plant until it is placed in the bottle, it is obvious that piping must be in good repair, properly handled, and clean. The following points should be observed in the inspection of sanitary pipes and fittings:

1. All piping, connections, and fittings should be of such diameter as to permit easy cleaning with a brush.
2. The piping and connections should have a heavy (particularly applicable in the case of tinned copper pipe), not readily corrodible, smooth finish. All sweated connections must be soldered smooth and flush.
3. Pipes with sharp corners, bends, crevices, or dead ends should not be permitted because of difficulty in cleaning.
4. All parts of interior surfaces of pipes or fittings, including valves, fittings, and connections, must be of a size and shape to be accessible for proper inspection either by sight or by touch. Bent or dented pipes, couplings, or fittings must be rated unsatisfactory.
5. The length and size of individual pipes have a relationship to cleaning and inspection. Pipe lengths should be reduced to a practicable minimum. Except in small installations, at least 1½-inch piping should be recommended; if one-inch pipe is used, the straight lengths should not exceed six feet.
6. Pasteurized milk and milk products should always be conducted through sanitary piping. (Some exceptions may be allowed in plants handling small quantities of by-products such as buttermilk and

cream, provided the procedure is deemed sanitary and the products are not endangered by exposure or unapproved handling methods.)

7. Cleaned pipes and fittings should be stored on a suitable rack and protected from splash, and the operator must prevent contamination of them by careless handling. (Inserting fingers into valves, pipe ends, connections, and fittings destroys the benefit of bactericidal treatment.)

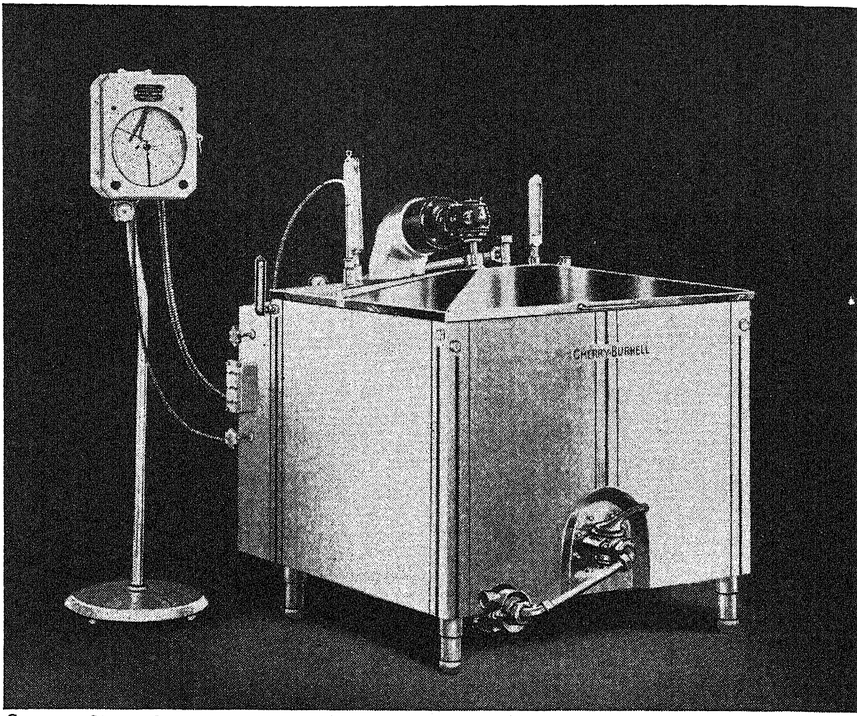
PASTEURIZING EQUIPMENT

The heart of the milk plant is the pasteurizing equipment. Since the holding or vat method of pasteurization is the one most frequently used, discussion here is confined to that method; for those wishing to make further study of other pasteurization methods, commercial literature should be consulted.

THE PASTEURIZING VAT (see Figures 26 and 27)

Pasteurizers of the vat type are made in round, square, and rectangular shapes. Modern vats are constructed of stainless steel or are glass lined, that is, glass fused on steel. With the stainless steel construction welded joints are used, making practically a one-piece lining and overcoming the objection to soldered joints which tend to crack from expansion and contraction. Milk in the vat is heated by different methods: one method maintains a volume of hot water in the jacket surrounding the milk which is agitated by steam injected to heat the water; another circulates steam-heated water in the jacket by means of a centrifugal pump. In the so-called spray vat, hot water at a regulated temperature is pumped through a pipe in the upper part of the jacket surrounding the milk. This pipe is perforated and streams of hot water are forced through against the outer portion of the lining containing the milk. In the case of glass-lined vats, heating is done by introducing steam directly into the jacket. At the point where the heat is introduced, baffles are provided to prevent overheating.[77] In addition to its heating function, agitation of the milk is necessary for proper pasteurization; it also helps to maintain a uniform mixture of the butterfat. Agitation should be gentle, but it must be sufficient to prevent temperature stratification during the holding period.

Inspection points. The inspection of a pasteurizing vat generally includes other apparatus used in conjunction with it. This discus-

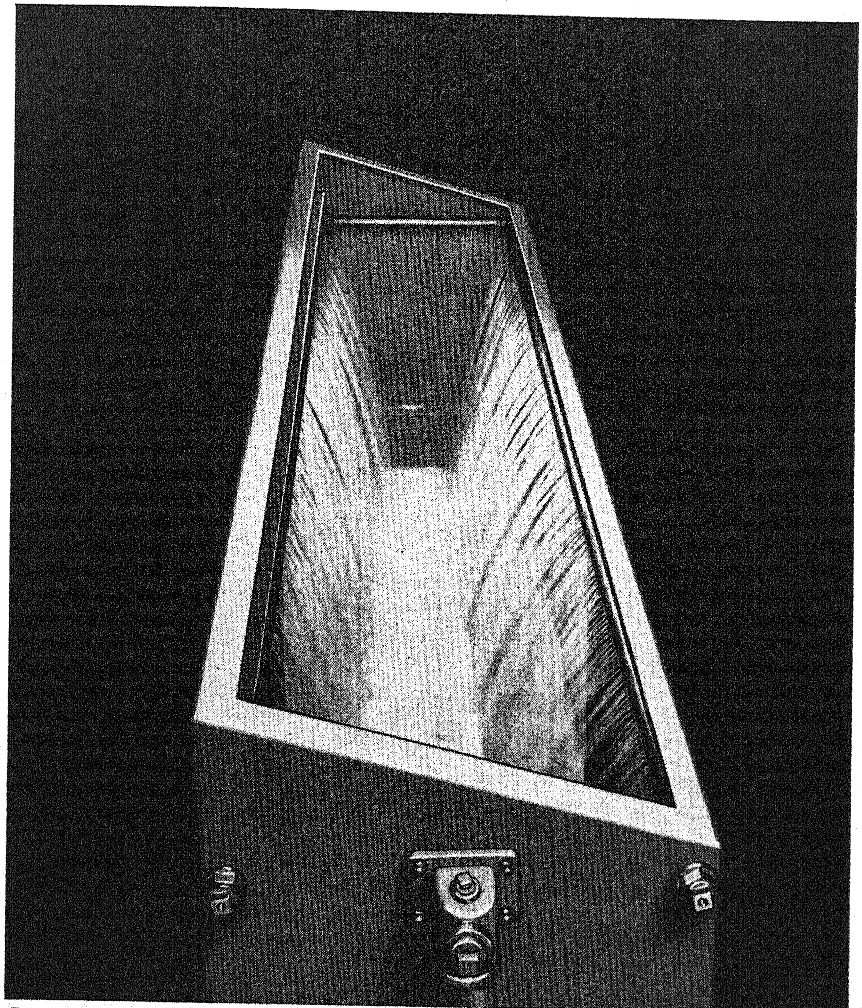


Courtesy Cherry-Burrell Corp., Chicago

Figure 26. A 150-gallon spray vat used in the holding method of pasteurization. Note sloping and overlapping cover

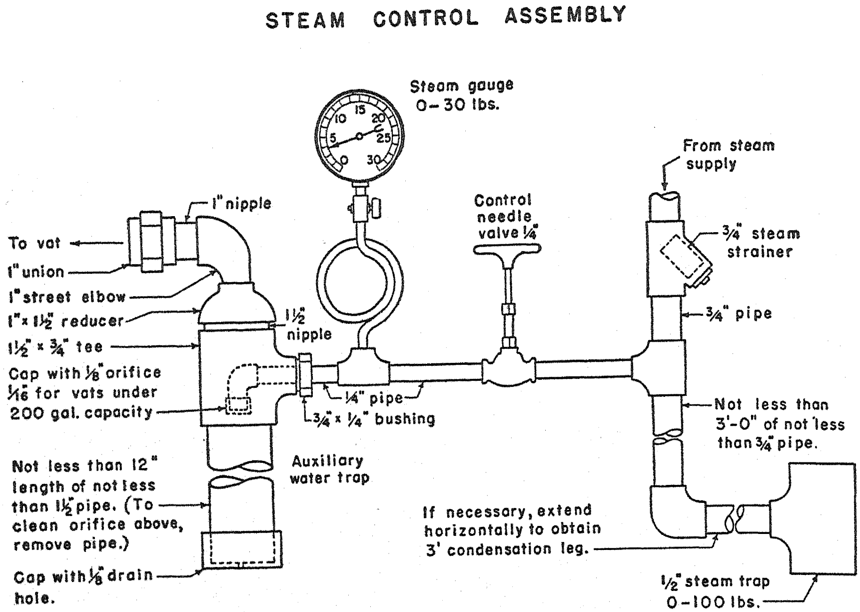
sion will therefore not be confined to the vat alone. It is assumed that all equipment is to be inspected for cleanliness, repair, and proper operation.

As far as the vat itself is concerned, the main points involve the covers, the openings through the covers, the foam-heating device, and the inlet and outlet valves. Covers should be designed to prevent any condensation or other foreign substance from getting into the milk. Covers are generally sloped so that any liquid accumulating thereon will be diverted to the floor. Vats having flat covers which are hinged at the center should have diverting aprons or fins to prevent liquid on the cover from dripping into the milk when the cover is raised. Openings in the cover through which pipes and thermometers are inserted must be protected by sleeves extending above the cover for a distance of about one inch, and pipe lines entering through the cover should be equipped with diverting aprons. Vat covers must be kept closed dur-



Courtesy Cherry-Burrell Corp., Chicago

Figure 27. The spray method of heating milk in a vat. The inner lining has been removed to show how hot water is sprayed along sides and ends



Adapted from U.S.P.H.S. Milk Ordinance and Code

Figure 28. Detail of foam or air-heating device to be used on pasteurizing vats

ing the entire pasteurizing operation, from the beginning of the filling period through the emptying period.*

The foam or air-heating device (Figure 28) is an arrangement whereby dry steam is sprayed over the surface of milk in a vat during the filling and holding periods. The temperature of the air above the milk should be 5 degrees higher than the milk, that is, 148° F. A check must be made to see that the steam is on and that the air temperature thermometer is at the correct point. The bottom bulb of the air temperature thermometer should be not less than 2 inches and not more than 3½ inches below the under side of the vat cover.

The valves of a pasteurizer, both inlet and outlet, represent critical points of inspection. Valves on inlet lines should be grooved to protect against leakage of raw milk into a vat during the holding period, and a groove or device should be provided in such valves to permit air re-

* This applies only when vats are filled through sanitary pipe lines, not when they are filled from cans.

lief and to prevent unpasteurized milk from standing in the pipe line between the valves and the surface of the milk in the pasteurizer. If this is not done, unpasteurized milk will be discharged with the pasteurized milk when the level of the milk in the vat falls below the level of the inlet pipe. If such valves are not provided, there must be a physical disconnection of inlet piping to a vat as soon as filling is completed.

The outlet valve must be so constructed that when it is in, or approximately in, the fully closed position no milk can leak past it into pipe lines. This is accomplished by mating grooves in the seat of the valve; these must extend throughout the entire depth of the seat. Grooves must be at least $\frac{3}{16}$ of an inch wide and at least $\frac{3}{32}$ of an inch deep at the center. Improperly constructed valves which allow raw milk or partially pasteurized milk to leak past their face into pipe lines can contaminate an entire supply and defeat the benefits of proper pasteurization. Modern vats are equipped with approved valves, but there are still many installations in use which do not have this safeguard. When a vat is not equipped with a leak-protector outlet valve, outlet piping must be left disconnected throughout the filling, heating, and holding periods. There are innumerable instances where because of an outmoded or leaky valve the pipe line from the vat to the milk pump has been found filled with unpasteurized milk. Every milk sanitarian should be fully cognizant of the important part valves play in the proper pasteurization of milk and should carefully scrutinize every installation.

Recording and indicating thermometers

Since proper pasteurization depends upon a temperature and time combination, it is indeed necessary that accurate thermometer equipment be provided. Recording thermometers are of two types, mercury actuated and vapor tension. The usual mercury range is from 30° F. to 220° F.; the vapor type ranges from 100° F. to 220° F.[50] The recording thermometer differs from the indicating thermometer in that the former has a pen-and-clock arrangement and the stem and bulb are made of metal instead of glass. The recording thermometer bulb is connected by a tube with a mechanism so constructed that the expansion of the mercury or gas in the bulb causes the pen in the recorder to draw a line on the chart; part of the arrangement is a

clock which revolves a disc containing the recording chart. The pen arm, moved either up or down by the expansion or contraction of the mercury or gas, records both temperature and holding time. The primary function of recording thermometers is to furnish a written record of temperature and time of pasteurization.

The indicating thermometer is a straight-stem type and contains no operating mechanism to get out of adjustment. The stem of the indicating thermometer is generally of stainless steel construction, varying in length from two to three feet. The scale range on the straight type vat thermometer is generally 130° to 210° F., with extension on either side permissive. Indicating thermometers are more accurate than recording thermometers and should always be used to determine correct pasteurizing temperature.

The recording thermometer (Figure 29). There are several important points involved in the inspection and observation of a recording thermometer:

1. Location—The recorder must be substantially mounted and placed where it is accessible.

2. Accuracy—The recorder must be accurate within 1° F. plus or minus, between 142° and 145° F. for thirty-minute pasteurization and between 159° and 162° F. for fifteen-second pasteurization. The accuracy of the recorder should be checked against an accurate indicating thermometer which has been tested against an approved inspector's test thermometer.* For new recording thermometers, or for recorders frequently out of adjustment, the following procedure should be followed: (1) The instrument should be adjusted, if necessary, to read correctly at some point between 142° and 145° F., or, in the case of fifteen-second pasteurization, between 159° and 162° F.; the adjustment should be made while the thermometer is connected with the pasteurization apparatus, and, as shown by the tested indicating thermometer, after a stabilization period of five minutes at constant temperature with the agitation device in operation. (2) The bulb should be removed from the pasteurizer and immersed for not less than five minutes in boiling water. (3) The bulb should then be immersed for not less than five minutes in melting ice. (4) The bulb should again be connected with the pasteurizer and the temperature brought to a point between 142° and 145° F. (or between 159° and 162° F.), as shown by the tested indicating thermometer under the same test conditions outlined under (1). At this time the re-

* Specifications for an inspector's test thermometer will be found on page 101 of the United States Public Health Service Milk Ordinance and Code.[84]

cording thermometer reading should not deviate more than 1° F., plus or minus, from the indicating thermometer reading.

In addition, the time accuracy as indicated by the chart rotation should be observed with a correct watch over a period of at least thirty minutes.

3. Thermometer charts—Check perforations made in chart by small pins set near the hub of the disc on the face of the recorder. When the nut which holds the chart in place is tightened, two small pins pierce the chart. Holes thus made should be intact; otherwise the chart will show a tear or additional holes if tampered with or turned by hand.

Check chart for proper graduations. Between 140° and 145° F. the length of the 1° F. scale division should not be less than one-sixteenth of an inch and the time represented by the smallest time scale division should not be more than ten minutes. The chord or straight line length of the ten-minute scale division should not be less than one-quarter of an inch between 142° and 145° F. When charts not meeting these specifications are found, the plant operator should be advised of the more desirable type and given a copy of specifications to be followed when recorders and charts for replacement are purchased.

Observations should be made of the manner in which charts are marked to give required information. On the face of the chart the operator should note the following information:

a. Date.
b. Number and location of the recorder if more than one is used.
c. Reading of indicating thermometer checked with reading of recorder at some point during the holding period.
d. Amount and grade of pasteurized milk or milk products represented by chart.
e. Record of unusual occurrences.
f. Signature or initials of operator.

This information can be more readily recorded if a rubber stamp incorporating the items is provided by the plant. Entries are made daily by the operator against each item stamped on the chart. Once each month the sanitarian should initial charts to signify that an accuracy test was made for both temperature and time. Charts should be preserved for a period of at least three months, or for a longer time if specified in local or state milk regulations.

The indicating thermometer (Figure 30). The accuracy of all indicating thermometers should be checked at least monthly against an approved inspector's test thermometer. This can be done by filling a milk can with water at pasteurizing temperature and placing the indicating thermometer and the test thermometer in it. The indicating thermometer being tested should be accurate within 0.5 de-

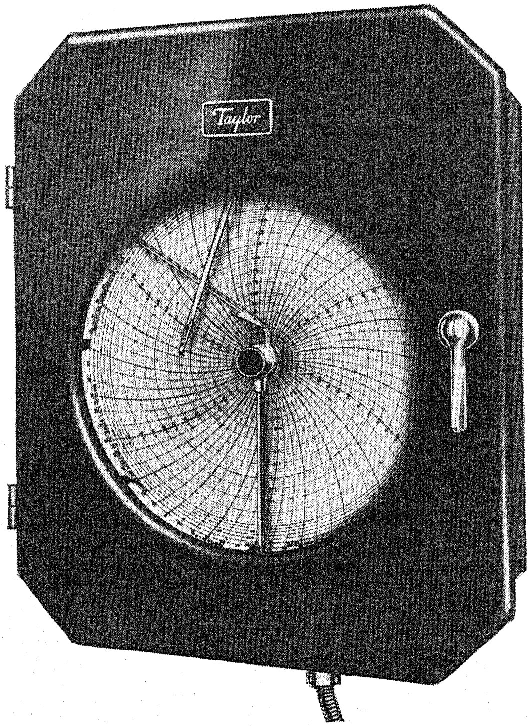


Figure 29. Recording thermometer used to record the time and temperature of milk pasteurization by the holding method

Courtesy Taylor Instrument Cos., Rochester, N.Y.

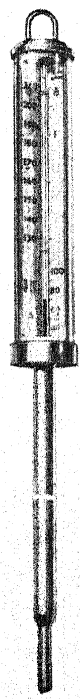


Figure 30. Straight-stem mercury-activated indicating thermometer

Courtesy Taylor Instrument Cos., Rochester, N.Y.

gree throughout the scale range (generally 130° to 210° F.). If the indicating thermometer is found to be inaccurate, the metal scale may be adjusted by removing the glass cover, loosening the small set screws, and slipping the scale up or down so that the temperature markings correspond with the etchings on the glass tubing (the glass tubing of indicating thermometers is generally etched at 142°, 143°, and 145° F.).

The following points should be observed in connection with indicating thermometers:

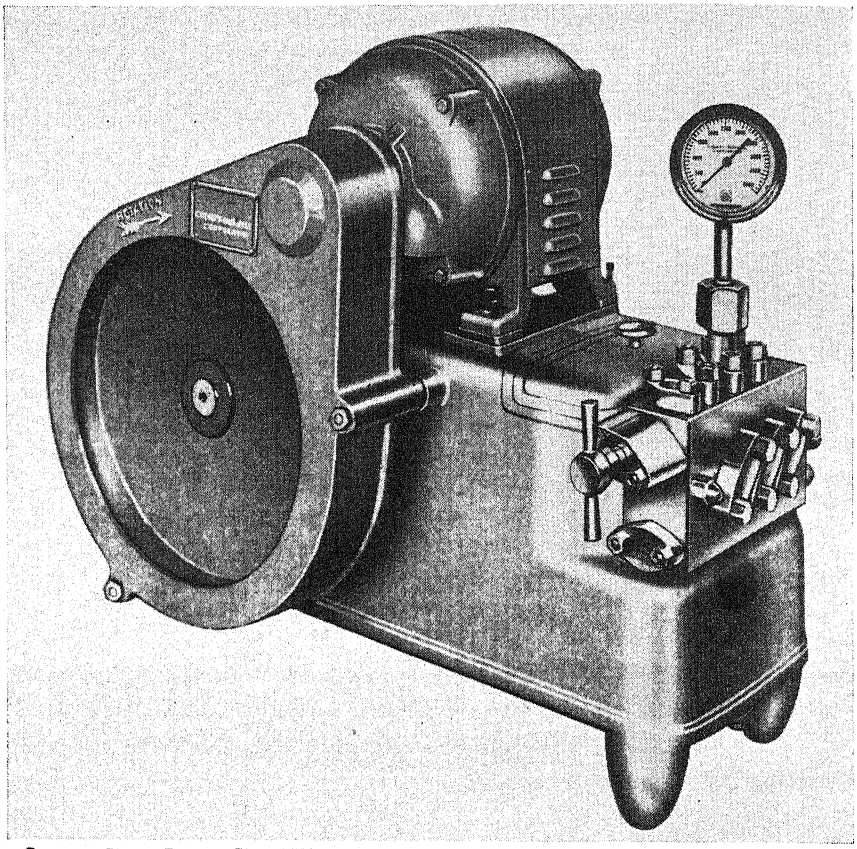
1. Indicating thermometers located on pasteurization pipe lines should be tested for *thermometric lag* before approval.*
2. Make sure that an accurate indicating thermometer is in place on each pasteurizer during the entire filling, heating, holding, and emptying periods. However, there is no objection to moving thermometer equipment from one vat to another, provided the above condition is met.

THE HOMOGENIZER OR VISCOLIZER

The homogenizer or viscolizer is a motor-driven machine (Figure 31) which forces liquid—milk, cream, ice cream mix, etc.—through very small apertures, known as homogenizer valves, under high pressure (1,000 to about 4,000 pounds per square inch; for milk a pressure of 2,500 pounds is generally used), thereby reducing the fat globules to infinitely small particles that remain dispersed through the liquid. The homogenizer is, essentially, a high-pressure plunger pump, each plunger chamber capable of withstanding high pressures. The pump forces the liquid to be processed in an even flow through a restricted opening between a valve and valve seat in the homogenizing chamber. Pressure in the machine is regulated by a valve, adjusted by a manually operated wheel or handle which puts tension on a heavy spring contacting the valve. The pressure is put on the liquid between the pistons and valve so that the liquid passes through at a very high velocity.[50]

Homogenization of milk has spread rapidly within recent years, particularly with the advent of soft curd and Vitamin D milk. The process improves the digestibility of milk and gives it more apparent

* Thermometric lag: "When thermometer is at room temperature and then immersed in a well-stirred water bath maintained at a temperature at which the thermometer to be tested reads 160° F., the time required for the reading to increase from 141° F. to 153° F. shall not be more than four seconds."[84]



Courtesy Cherry-Burrell Corp., Chicago

Figure 31. Modern homogenizer, so constructed that milk contact parts can be disassembled for cleaning

body. Many homogenizers used in the dairy industry today are of the older type and are so constructed that proper cleaning and bactericidal treatment are very difficult if not almost impossible; the later models, however, incorporate sanitary safeguards and are easily dismantled for cleaning.

Inspection points. Milk contact parts of the homogenizer, like all other milk-processing equipment, must be dismantled daily for cleaning. The following points are important:

1. Instruct the operator to run warm water through the machine as quickly as possible at the end of the day's run.
2. Have the plunger cover removed and the plunger chamber, plunger

rod, discharge valve, and suction valve thoroughly cleaned. (On late model machines the plunger packing gland and packing can be removed for cleaning.)

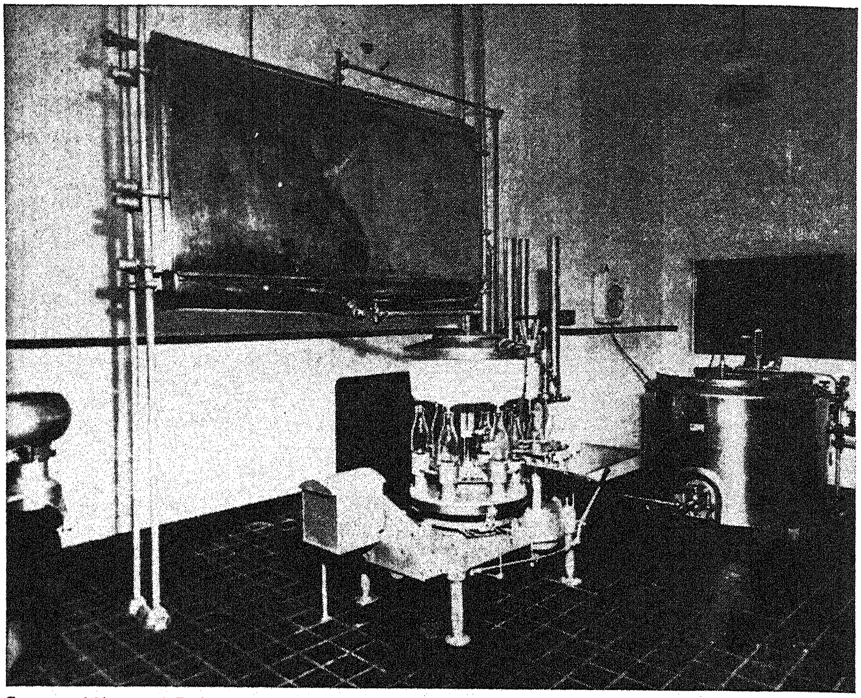
3. Inlet and outlet openings, generally of stainless steel pipe, must be properly cleaned.
4. Advise the operator to pump bactericidal solution through the machine before using.
5. Advise the operator about a fine sediment which frequently appears in bottled homogenized milk. Such sediment may appear evenly distributed over the bottom or it may be in the form of clumps or flocculent masses; the color ranges from reddish brown to gray or black. This condition is not due to insanitary conditions but is attributable to the presence of great numbers of leucocytes and epithelial cells which are found in varying amounts in all milk.[54] In non-homogenized milk these cells are carried up with rising fat globules. Where no rising of the globules takes place, the cells, because they have a higher specific gravity than the milk, settle at the bottom of the bottle as sediment. Since a high leucocyte count may be an indication of an udder infection, usually mastitis, in the dairy cow, it is important that this type of sediment be avoided. In homogenized milk it is frequently cause for complaint by consumers, who reason that the sediment is due to careless handling.
6. Check to see that outside and underneath parts of the machine are kept clean.

COOLERS AND BOTTLERS

Coolers

The milk cooler of the surface or tubular type is an apparatus designed to cool milk rapidly to a temperature of 50° F. or below. In the majority of plants, milk at or slightly below pasteurizing temperature is pumped to a distributor or spreader pipe at the top of the cooler. Milk flows from this pipe through small perforations downward and over the outside surface of a series of closely connected horizontal pipes or pressed stainless steel plates while refrigerant circulates inside. Irrespective of the kind of cooler used, whether cabinet, internal tubular, or simple surface type, the principle of operation is basically the same, namely, an exchange of heat from milk to refrigerant.

Inspection points. There are at least two major points to be considered in connection with milk coolers: the first is to make sure that milk is being cooled to 50° F. or below; the second is to see that the cooler is properly constructed and protected so that there is no pos-



Courtesy Minnesota Dept. of Health

Figure 32. A covered milk cooler is essential for protecting pasteurized milk from contamination

sibility of contaminating the pasteurized milk. The following observations should be made:

1. The temperature of the milk as it leaves the cooler should be tested with an approved thermometer. This may be done by placing a sterilized thermometer in the milk in the bottom collecting trough. The milk should be below 50° F.

2. The cooler surface should be smooth, free of dents, and should show no exposed copper. The cooler must be level to give an even flow of milk over the entire surface.

3. The cooler should have a tight-fitting cover (see Figure 32). (If such cover is not provided, the cooler must be in a separate, well-ventilated room, although this is not generally recommended since ventilation and maintenance of the room are frequently difficult. It is more feasible and economical to equip the cooler with proper one-piece covers suspended on tracks; covers built in sections to be taken down for cleaning almost invariably become damaged in the process.)

4. Cooler covers must overlap at the top and must clear the bottom

collecting trough so that any condensation on the inner side of the cover will not wash bacteria into the milk.

5. A gap of at least one-quarter of an inch must be left between header sections to facilitate cleaning. If header ends are not completely enclosed within the cooler covers, small metal deflectors may be soldered on at the bottom of the header to prevent condensation on the header ends from draining into the milk. Shortening the bottom collecting trough will also act to prevent drip from getting into the milk.

6. Cooler covers must be kept tightly closed whenever the cooler is in use, and should be thoroughly cleaned at the end of each day's operation.

Bottlers

The bottling and capping of the milk and the placing of bottles in appropriate cases constitute the final plant operation before the milk is put in the cold storage room. Each step, from the point of pasteurization to the placing of the milk in the final container, requires close scrutiny to prevent contamination. When correctly carried out with proper equipment, the bottling operation adds another link in the chain of protection; when it is improperly carried out, contamination may be readily introduced. The bottler is essentially an apparatus fitted with a metal or enamel collecting bowl into which the milk flows from the cooler. From this bowl the milk flows through tubes, by gravity or by vacuum, to the bottle. Mechanical bottlers may be hand operated, semi-automatic, or fully automatic.

Inspection points. The following are important:

1. The bottler must be covered so that nothing can fall or drip into the milk as it is held in the bottler bowl. The cover must be so constructed that it slopes gradually from the center to the periphery, causing any condensation which collects to be diverted to the floor.

2. Bottler floats must be adjustable without removing the cover. Frequent lifting of the bottler cover by the operator may introduce hand contamination or allow condensation to drip into the milk.

3. The inlet pipe leading to the top of the bottler must have an umbrella-like collar or diverting apron welded or soldered to it (see Figure 33). Some bottlers have a perforated metal strainer, which should have an overlapping cover, equipped with an integral upward projecting metal sleeve through which the inlet pipe enters. The diverting apron on the inlet pipe prevents condensation from running down the pipe and into the milk.

4. The filler or air tubes and the rubber valves which seat over the top of the bottle during the filling operation should be dismantled daily and

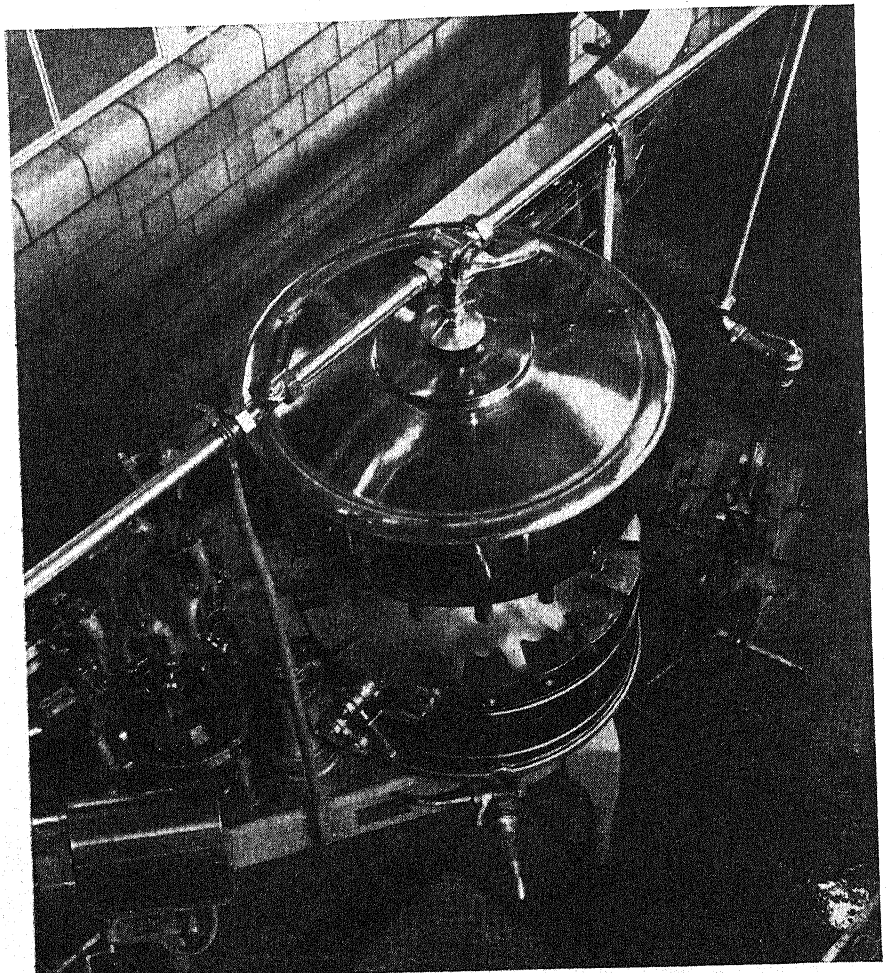


Figure 33. A diverting apron on the inlet pipe to the bottler prevents the entrance of drip or condensation into the milk

thoroughly cleaned. Rubber valves which are split or which show considerable wear should be replaced. Valves and rubbers may be soaked in a chlorine solution; it is highly desirable to dip these parts in a chlorine solution before assembling them. The installation of a drip deflector between the rubber valve and the filler sleeve is also important.

5. The capping mechanism, though not necessarily considered a part of the bottler, is intimately connected with the filling operation and must be checked for cleanliness. Droplets of milk continually splash into the heads of mechanical cappers, making daily cleaning imperative. Another point should be mentioned here: clean bottles may be carried to the bottler on automatically operated bottle conveyors. Such conveyors must be provided with overhead shields from the bottle washer to the bottle feed star; conveyors without shields allow for possible contamination of the clean bottle.

In presenting the foregoing discussion of certain essential pieces of plant equipment and related inspection points, the author realizes that some apparatus deserving consideration may have been omitted. Likewise, all critical parts of equipment contributing to the continued safety of the pasteurized product may not have been covered. However, a sanitarian who studies milk plant equipment in his territory in the light of the necessary safeguards enumerated here will find that as these essentials become an integral part of pasteurizing plant equipment safer milk will be the net result.

VIII

PASTEURIZATION PLANT PRACTICES

The manner in which pasteurization equipment is operated is at least as important as the particular type or model of equipment used. Plant personnel must have an appreciation of the pasteurization process, an understanding of sanitary practices, and an intent to operate equipment correctly and carefully. Experience has indicated —notably in Oakland, California,[35] in Illinois,[49] and in Lansing, Michigan—that an education program for milk plant workers conducted by the health department and aided by cooperating agencies is one effective way of enlisting interest and cooperation in improving milk plant practices.

EDUCATION OF PERSONNEL

The type of inspection that is built solely upon the principles of "policing" will fail simply because the operator looks upon the sanitarian as "the law." On the other hand, if the plant worker is of a reasonable turn of mind, he welcomes explanations and discussions about his job, since in many instances all he was told at the time he was hired was which buttons to push or which valves to turn in order to get certain results. Education of plant personnel can be accomplished by two methods, or, better still, by a combination of them: first, taking the time to explain procedures on the spot; and second, inviting operators to attend organized meetings or instruction classes. In Illinois the combination of a mobile field laboratory unit, which went from plant to plant, and subsequent meetings organized by the health department has been effective. In Oakland, California, pasteurizer operators are given a manual of approved plant procedures by the health department; they are then required to pass a written examination before they can be licensed as qualified operators.

Plant employees and health departments must work closely together to solve the many problems attendant upon proper milk plant operation. These problems involve the personal practices of the operators and employees themselves and the understanding and proper execution of the sanitary safeguards that must surround the pas-

teurization process. Underlying these must be a desire to protect the product at each and every point in its travel through the plant.

PERSONAL HYGIENE

Although the personal practices of employees may seem quite elementary and obvious to the public health worker, the plant employee himself may not be sufficiently conscious of them. In any course of instruction, as well as in personal discussions, the following points must be stressed:

Care of the hands. Employees must understand that the hands may carry contamination to milk or equipment. Hands soiled with discharges from bowel and bladder or nose and throat can contaminate milk. It logically follows, then, that the hands must be thoroughly washed with warm water and soap after the toilet is used or whenever the hands become soiled from contact with unclean articles or infectious material. Failure of employees to appreciate the significance of this safeguard and to observe it conscientiously can result in difficulty. An appropriate sign directing employees to wash their hands should be posted conspicuously in toilet rooms and in other parts of the plant.

Clothing. Washable outer garments in the form of a uniform or coveralls must be worn to protect milk and equipment from contamination. Street clothing, because it is contaminated through normal wear and by outside contacts, and because it is not readily laundered, is not, of course, suitable for milk plant use. Aside from sanitary considerations, clean clothing is esthetically necessary for an appearance of cleanliness and efficiency.

Personal habits. In this category are individual habits and practices frequently encountered. Spitting about the plant, promiscuous coughing and sneezing while working, the use of tobacco, picking at the nose and face, or working while suffering from skin conditions of an infectious nature must not be allowed. Regulating such personal practices is indeed difficult, and the sanitarian must be tactful and reasonable when he approaches a worker about them. One means of handling personal situations is to quietly take the offending worker aside and courteously explain the basis for requesting the discontinuance of careless personal practices.

Care in handling equipment. The plant worker must understand

the necessity for care in handling sanitized equipment so that he does not contaminate it. Fingers must not be placed inside clean pipes, pipe fittings, or containers. The hands must not be run over sanitized surfaces of milk coolers, vats, bottler bowls, and similar parts of pasteurizing and processing equipment. Milk caps must be kept in tubes and no loose caps used; at the beginning of each run the first milk cap from each tube must be discarded. No equipment such as pasteurizer valves, pipe fittings, indicating thermometers, and so on should be placed or laid where it is subject to contamination by splash. Any piece of equipment accidentally soiled must be cleaned and given bactericidal treatment before being placed in service again.

Plant routine

The second factor in personnel education involves the mechanics of processing and operating methods. The man who operates the pasteurizer, for example, should know the reason why a temperature-time combination of 143° F. and thirty minutes is required for proper pasteurization. He should know that pasteurization destroys harmful bacteria, and that there are certain pathogens which may be in the raw milk when it is received. He should be impressed with the necessity for accuracy in operating the pasteurizer, and should do nothing to contaminate the product while it is under his care. The same type of information should be imparted to the other plant employees, since one operation cannot be isolated from another if all the milk in every bottle is to be safe. When one realizes that a rather frequent help turnover is commonly experienced in the milk business, it is easy to understand why instruction of personnel in the elements of sanitation is absolutely necessary. There should be at least certain key persons in the plant who understand the public health value and meaning of all operations, so that a new employee will not endanger the product because of avoidable mistakes. The sanitarian, then, if he is to assume the role of a counselor, must be well acquainted with plant routine so that he can explain fully the meaning of each operation.

Cleaning of equipment. The cleaning of milk plant equipment involves a large labor outlay; in fact, the clean-up may take as much time as the actual processing. The question of effective cleaning

routine is one which confronts the sanitarian in every milk plant under his jurisdiction. The necessity for and the importance of good cleaning procedures cannot be over-emphasized. Milk with a low bacterial content cannot be produced unless equipment is physically clean. Residual milk wastes, butterfat, and similar remaining soil will serve as a potent source of bacterial contamination to milk. The case then is clear: the sanitarian's responsibility is to impress upon all plant personnel the necessity for carrying out effective cleaning methods and at the same time be properly versed in them himself so that his recommendations will be practical and workable. Although it is neither possible nor feasible to discuss the cleaning of each separate piece of milk plant equipment in this text, one example has been selected to illustrate the basic principles of clean-up routine.[28] Let it be assumed that the piece of equipment to be washed is a pasteurizing vat. The cleaning procedure should be as follows:

1. Immediately at the end of the day's operation, or when finished with the vat, flush it with water at about 110° F. Warm water is much more effective than cold water in removing butterfat. Immediate rinsing helps to prevent the setting of milk solids and makes cleaning easier.
2. Disassemble the equipment, that is, remove all milk contact parts where this is possible, to facilitate cleaning—thermometer, milk inlet piping, and sometimes agitators can be removed.
3. Remove all thick deposits from the inner sides of the vat. Use a stainless steel sponge or a brush and a pail of water. Rinse all debris from the vat.
4. Close the valve and place about 2 inches of warm water in the vat; then add the proper amount of washing powder.
5. With a bristle brush, scrub thoroughly the sides, bottom, and lid of the vat, as well as milk inlet openings, thermometer openings, and agitators.
6. Wash outside of vat with bristle brush.
7. Remove valve, draining out all washing solution; then rinse entire vat with warm water.
8. Wash all assembly parts in the wash tank and replace on vat.
9. Dry vat by lowering lid and letting steam blow into the vat for a few minutes so that all parts become hot enough to dry rapidly.
10. Leave vat lid partially open so that moisture will not collect inside.

In addition to the cleaning routine, a careful check should be made to see that cleaning equipment is of the right kind and in good condi-

tion. Cleaning brushes must be of the proper type for the particular operation involved. Brushes for pipe lines, for example, are mounted on a rod and have brass, nickeled silver, or phosphoric bronze bristles; the bristles are substantial and stiff. Brushes must be in satisfactory condition and of the correct size to fit each diameter pipe snugly. Brushes for cleaning surfaces of vats, coolers, and tanks are of softer fiber construction than those used for pipe lines; again, these must be in a good state of repair.

For washing pipe lines, wash tanks long enough to accommodate the longest piece of pipe must be provided. A tank about 12 inches wide and 12 inches deep, and of ample length, is necessary so that pipes can be submerged in the washing solution. Tanks that are too wide and deep waste washing solution and increase costs. Pipes and fittings cannot be washed in dirty water; therefore, a fresh solution should be prepared as soon as the wash water become milky or the chemicals are spent. The routine followed to effectively clean equipment is of real concern to the sanitarian, first, because he wants milk and dairy products to contact only clean surfaces, and secondly, because physically clean equipment is a prerequisite to effective bactericidal treatment.

*Bactericidal treatment of equipment.** Bactericidal treatment is considered to be the application of any effective method or substance, for the destruction of bacteria, which does not adversely affect the equipment or the product. The bactericidal process may be carried out in one of the following ways:

1. Treatment of equipment with steam. In this case an exposure period of five minutes must be allowed after the flow of steam from the outlet has reached 200° F. Treatment with steam is applicable mainly to enclosed equipment such as pipe lines, pre-heaters, filters, valves, tubular holders, and regenerative coolers. Steam treatment of open equipment such as vats, surface coolers, tanks, and bottlers generally cannot be considered effective. The noise and commotion from escaping steam may be impressive, but if the exposure period is not sufficiently long and if the steam is not concentrated on a surface, its effectiveness is open to question. The primary value of steam obviously is the heat transferred from it to equipment, and unless the entire surface is heated to 200° F. bactericidal action will not result.

* Besides the bactericides mentioned, newer sanitizing agents known as quaternary ammonium chlorides have been reported to be effective.

2. Immersion in or exposure to a flow of chlorine solution of proper strength for at least two minutes. While a chlorine strength of at least 50 p.p.m. is recommended, there is evidence to show that the pH value of the solution has a decided effect upon its germicidal efficiency. Scales and Kemp[72] have demonstrated that a solution containing 50 p.p.m. of available chlorine (sodium hypochlorite) at a pH of about 6 will give as satisfactory germicidal results as a solution containing 255 p.p.m. of chlorine with a pH of about 10. Their studies show further that, when the pH value of a solution is 8 or below, 90° F. appears to be a better temperature for bactericidal treatment than any lower one. These investigators used acid sodium phosphate for adjusting the pH to the desired reaction. The quantity of solution passing through or over equipment has an effect upon bactericidal action. Devereux and Mallmann[22] have reported that a rinse of 50 gallons of a 10 p.p.m. chlorine strength is superior to 10 gallons of a 50 p.p.m. strength, although the total chlorine content of each is exactly the same. This is explained by the fact that the weaker solution is more efficient because of the longer period necessary for the rinse solution to pass through the equipment. Investigation has shown that under ordinary commercial conditions an exposure time of three to five minutes gives more effective results when chlorine is used than a two-minute exposure.

When chloramine T compounds are used, longer exposure periods should be allowed since these display a delayed germicidal action. If it is unnecessary to secure immediate germicidal action, as when equipment is treated an hour or more before use, chloramine compounds can be effectively used. It should again be emphasized, however, that efficient bactericidal action is dependent upon physically clean equipment and that the use of any bactericidal agent cannot be considered a substitute for proper washing and cleaning.

3. Exposure of equipment to hot water at 170° F. for at least five minutes. In this case the water temperature must be at least 170° F. at both inlet and outlet. This form of bactericidal treatment if correctly followed is effective, though it is somewhat inconvenient and expensive for use on a large scale. It is especially recommended if difficulty with heat-resistant organisms is being experienced; in such cases the temperature of the water should be raised to 200° F. or above and the exposure time increased to ten minutes.

Plant housekeeping. Other plant practices designed to keep the plant and its surroundings in sanitary condition and to prevent contamination of milk or equipment should be investigated by the sanitarian. These involve such considerations as the following: storage of caps and containers; storage of equipment; protection of ingredients such as syrups, sugar, fruit concentrates, and chocolate powder;

disposal of wastes—for example, glass, paper, and discarded containers; and cleanliness of delivery vehicles. Although each of these items individually and collectively is of significance, it is felt that the sanitarian will readily observe any infractions as he makes his inspections and, by exercising reason and good judgment, bring them to the attention of the management for correction. As has been pointed out in other portions of this text, those factors of greatest public health value should always be given emphasis first. Indeed, it would be quite pointless to become involved with some minor item while a major one was being neglected.

IX

LABORATORY PROCEDURES USED TO EVALUATE A MILK SUPPLY

THE laboratory examination of milk is one of the most valuable and necessary aids to the administration of a milk control program; without a reasonable amount of laboratory service a milk program is decidedly handicapped. There are several well-recognized procedures for determining the safety and sanitary quality of milk,* and although the sanitarian may not personally conduct such tests, he must be conversant with them and with their interpretation. It is not the purpose of this text to describe precise and detailed laboratory procedures, since this is a study in itself. The reader will find complete laboratory instructions in Standard Methods for the Examination of Dairy Products, published by the American Public Health Association.[4] The discussion of laboratory procedures presented herewith will be devoted mainly to a consideration of their purpose and interpretation.

AGAR PLATE METHOD (Standard Plate Count)

The agar plate method is the laboratory procedure most commonly used to estimate the bacterial populations of milk and dairy products. In this method a one-ml. portion of the milk sample is diluted with sterile distilled water to give resulting dilutions ranging from 1 to 10 to 1 to 10,000. A one-ml. portion of the selected dilution is then placed in a Petri plate, growing medium (tryptone-glucose-extract milk agar) is added, and the sample is incubated at either 32° C. or at 37° C. for 48 hours.[4] At the end of this period a count of colonies developing on plates is made. The number of colonies counted multiplied by the dilution factor gives what is known as the standard plate count or the estimated number of bacteria per milliliter of sample.

* At the School of Hygiene and Public Health of Johns Hopkins University, work has been done on the so-called "choline test." This method is based upon the relatively rapid quantitative determination of choline as a decomposition product of lecithin. Lecithin breaks down with aging of milk, exposure to oxygen, and high temperatures. Choline is an end product of this change. (Journal of Milk Technology, September-October 1942, pages 259–260.)

Interpretation and Field Use

The interpretation of the result is based upon the fact that the bacterial populations in milk and dairy products serve as an index of sanitary quality. In general, a low bacterial population indicates correct handling and processing, whereas a high count may indicate faulty methods or practices at one or more points in production or processing. Standards have been set for permissible bacterial populations in milk that are considered reasonable of attainment when milk is correctly handled. Probably the best known and most generally recognized standard is that set by the United States Public Health Service Milk Ordinance. In it the standard for Grade A pasteurized milk is a plate count of not over 30,000 per milliliter when the logarithmic average of samples is taken; for Grade A raw milk 50,000 per milliliter is established as the maximum acceptable count.

The establishment of definite bacteriological standards is obviously essential as a control measure, frequently necessitating revision in plant operating methods on the part of the dairy industry. Slipshod methods both on the farm and in the plant are quickly revealed by the standard plate count. Counts found to be consistently high serve as a danger signal to the dairyman and to the plant operator. To the sanitarian, they point to the need for investigation and close scrutiny of methods employed. The interpretation of the count in terms of remedial action needed is in the truest sense the primary value of this laboratory aid.

It would be decidedly impractical to attempt an enumeration of all possible causes for high counts since frequently they are attributable not to one cause but to a combination of circumstances. There are, however, certain suggestions that may be advantageously followed as a guide in locating the cause of trouble. Suggested procedure for a hypothetical problem—attempting to locate the cause of high counts in Grade A pasteurized milk—is outlined below:

1. If possible, make a direct microscopic examination (described on page 138) of the pasteurized milk to determine the most predominant type of organism.
2. Inspect every piece of milk-processing equipment for cleanliness, absence of milk stone formation, and effectiveness of bactericidal treatment. Unclean equipment may be the cause.
3. Check temperature of cooling and temperature of milk in cold stor-

age room. Improper cooling and holding at temperatures above 50° F. may be the cause.

4. Determine disposition or use of returned pasteurized milk. Repasteurization is conducive to growth of heat-resistant bacteria.

5. Make inquiry into the method of standardizing milk: Is skim milk immediately cooled after skimming or is it added at separating temperature (90° to 100° F.) to a vat of cold milk? Holding warm raw skim milk in cans preparatory to standardizing increases the bacteria count and favors growth of heat-loving bacteria. Determine standard plate count of skim milk or cream used for standardization.

6. Inspect efficiency of bottle-washing operation. Collect a series of presumably clean milk bottles for bacteriological examination.

7. Collect a series of line samples during course of plant operation. Collect samples of pooled raw milk when vat is full and just before heating begins. Take pasteurized samples from vat at end of thirty-minute holding period, collect other samples from cooler and out of bottler, and then take bottled milk samples, all from the same batch of milk. This procedure should disclose: first, the efficiency of pasteurization, by showing the bacteria count of the raw milk and the count (normally a reduction) after pasteurization; second, whether bacteria are being picked up as the milk flows through processing equipment.

8. Observe the can-washing operation and examine milk cans for condition and cleanliness. Cans with open seams, rust spots, and those badly battered and dented cannot be effectively cleaned; cans in poor repair must be condemned and the producer advised to have them rebuilt and retinned or replaced with new ones.

These eight suggestions apply only to operations within the plant, which is, of course, just one phase of the problem. The sanitary quality of the raw milk supply plays a very prominent role, and if the contributing cause of high counts does not appear to be attributable to faulty plant operation, a thorough investigation must be made of the milk previous to pasteurization. The following procedure is recommended:

1. Collect a sample of milk from each producer shipping to the plant.*

2. Examine milk from each producer by the direct microscopic method, described below. In addition to determining the bacterial con-

* Occasionally the milk from certain producers can be omitted from the sampling procedure. Process samples frequently show one batch of pasteurized milk with a low count, another with a high. Individual sampling from the group of producers whose milk is used in the batch giving satisfactory results may be temporarily omitted. Producers whose milk shows a high count, or those whose milk fails to show a reasonable reduction as a result of laboratory pasteurization, should be visited so that unsatisfactory production methods can be remedied.

tent of the milk, an experienced bacteriologist can differentiate types of organisms indicative, for example, of poor cooling, dirty utensils, mastitis infection, and general insanitary production methods. The standard plate count is not recommended at this point because the direct method is more rapid and less expensive. In addition, the plate count simply gives an estimate of the total bacterial population, without disclosing the types of organisms most likely to be the cause of the trouble. If laboratory facilities are such that the direct microscopic method cannot be used, the methylene blue test (page 144) or the resazurin test (page 145) may be employed.

3. Pasteurize the raw milk in the laboratory for two hours, and again examine the samples by the direct microscopic method. (Laboratory pasteurization is discussed on page 146.)

4. Make field investigations at farms where tests show milk of poor quality.

Although the milk control official is vitally interested in assuring the public a low count, high-quality milk, his inspections and investigations must be supplemented by diligence and cooperation on the part of milk plant personnel. Plants whose volume of milk is sufficient to warrant the services of a bacteriologist or field man should be aggressively encouraged to conduct their own tests and farm investigations. The procedures which have been suggested above can be followed by both the milk control official and the plant supervisor when attempting to locate and remove the cause of high bacteria counts.

DIRECT MICROSCOPIC METHOD

This method for determining bacterial populations "consists of an examination, with the aid of a compound microscope, of stained films of milk and cream dried on glass slides."[4] An 0.01-ml. sample is placed on an area one centimeter square on the glass slide, dried, and stained. The microscope is adjusted so that the operator knows what part of a milliliter of the sample is being examined in each field area. "The direct microscopic technique is used chiefly in routine control work for making rapid estimates of the number of bacteria present rather than for making time-consuming counts of the number of individual bacteria present."[4] The direct microscopic method appears to have particular application in the examination of the raw product and is now being extensively used.

INTERPRETATION AND FIELD USE

The sanitarian's work in the field is greatly facilitated when the laboratory is able to report the probable cause of insanitary milk. For example, if the examination shows organisms originating from a lack of cleaning or care of utensils, the sanitarian can approach the producer from that angle. The fact that the laboratory can determine within reasonable limits the probable cause of a high count impresses the producer and makes him feel that the work is thorough.

The health department may mail reports to the milk producer, giving him results of the laboratory examination. How this is done will depend primarily upon the method of local administration, but the following type of report form is suggested:

______________Department of Public Health

Dear Producer:

The laboratory examination of a milk sample from your farm made on ______________ showed the milk to have a bacteria count of ____________ per c.c. which is in excess of 200,000, the maximum acceptable standard for good milk. We find this unsatisfactory condition to be due to lack of care as indicated by the item or items checked below.

☐ 1. Utensils not properly cleaned and sterilized.
☐ 2. Poor cooling—lack of prompt cooling and holding.
☐ 3. Dirt or manure from cows' flanks getting into milk, or wet milking.
☐ 4. Dust from barn or milk house getting into milk.
☐ 5. Poor production—insanitary in all respects.
☐ 6. Udder infection—watch for gargety milk.
☐ 7. Cells (a) Milk used too soon after freshening.
(b) Milk used too long at end of lactation period.
(c) Injured udder.

CHECK OVER YOUR MILK HANDLING ROUTINE CAREFULLY.

Your milk must show a satisfactory test when the next sample is examined if a shut off is to be avoided. Rejected milk means a loss to YOU, take steps now to prevent it.

In practice, this form is sent to a producer as a warning and to inform him that the number of bacteria found in the milk sample exceeds the allowable bacterial limit; the form is also marked to show the probable cause of the trouble. A report of this type frequently makes a farm call unnecessary, since the producer may find and correct his own difficulty.

PHOSPHATASE TEST

This test, devised in 1935 by two English scientists, Kay and Graham, measures the efficiency of pasteurization. Raw milk contains an enzyme phosphomonoesterase which is heat sensitive. When milk has been properly pasteurized this enzyme is inactivated and its ability to liberate phenol from phosphoricphenyl esters is lost. The enzyme, if present, reacts with a substrate (disodium phenylphosphate), liberating phenol which is quantitatively measured by the use of an indicator. The presence of a blue color or varying shades of it, measured colorimetrically, indicates faulty pasteurization or subsequent contamination with raw milk.

Interpretation and field use

The efficiency with which the pasteurization process is carried out can now be readily and comprehensively determined by this test. Prior to the use of the test, a check on the accurate control of pasteurization was largely dependent upon the time and temperature readings, as shown by recording thermometer charts. The contribution made by this test in the field of milk control has been outstanding; in fact, control officials are finding it one of their most valuable aids in assuring that milk labeled "pasteurized" fulfills the true meaning of the term.

In the field, a laboratory report designating milk as under-pasteurized calls for immediate investigation. An unsatisfactory phosphatase test may be attributable to one or more of the following causes; the sanitarian should be familiar with all of them.

1. Pasteurization below correct temperature. A drop in temperature of one or two degrees below 143° F. is detected by the test. The accuracy of both recording and indicating thermometers should be carefully checked.

2. Shortage in holding time. It is sometimes found that the operator will start drawing off milk before the full thirty-minute period has elapsed. In that case, the first part of the batch will be under-pasteurized. All the milk must be held for a full thirty minutes. Time shortages of between two and five minutes are detected by the test.

3. The addition of raw products during or at the completion of the holding period. The addition of raw cream, whole milk, or skim milk for purposes of standardization, besides subjecting the pasteurized product to contamination, will also give a positive phosphatase test.

4. Leaky valves. An outlet valve that permits raw milk to leak into pipe lines serves as a source of contamination, and at least the first portion of the milk drawn off will give an unsatisfactory phosphatase result. An inlet valve that permits raw milk to leak past it into a vat is another source of contamination. Unless leak-protector inlet valves are used, inlet piping must be disconnected before heating begins.

5. Failure to close outlet valves. Instances have been found where an operator fails to close an outlet valve before introducing raw milk into a vat. When this occurs, the milk standing in the pipe line between the milk pump and vat is not pasteurized at all.

6. Failure to control foam on the surface of the milk in the pasteurizing vat. Unless foam-heating devices are employed, ineffectively heated foam may be a contributing factor to a positive phosphatase test.

7. Use of phenol. While there is rather small likelihood that a chemical such as carbolic acid would be used about a dairy plant, the fact that phenol will give a false positive test should be mentioned. The use of soap or cosmetics containing phenol in a milk-testing laboratory must be avoided.

Shortly after the adoption and use of the phosphatase test, experience indicated that milk pasteurized on Sundays and holidays was quite likely to show a positive result. This was explained by the fact that plant personnel started operating later than usual and hurried, or were anxious to finish the day's run a little early and so cut the holding time short. Also, experience has shown that an occasional unannounced Sunday visit to some milk plants may be quite revealing and profitable. In the phosphatase test the sanitarian has a tool of great value; in fact, its development is probably the greatest contribution to the safety of milk since the introduction of pasteurization itself.

SEDIMENT TEST

The sediment test is used to determine the amount of undissolved visible dirt in milk. Under practical field conditions, tests are usually made directly from cans of milk received at a plant. Several companies manufacture sediment testers of the tube type. Milk is drawn from the bottom of the can up through the bottom of the tube by a vacuum created by a rubber plunger inside the tube. The milk is then expelled from the tester by pushing the plunger down and forcing the milk through a stiff cotton disc, one inch in diameter, upon which the sediment is collected. Thus the amount of sediment in a one-pint

sample is determined. For bottled milk, a small vacuum-type sediment tester may be used in the laboratory; the process of filtering may be hastened by heating the milk.

Interpretation and field use

The sediment test is simply a means of grading milk for cleanliness. The amount of sediment collected on the cotton pad determines the sediment grade, generally designated as clean, fairly clean, dirty, and very dirty. Photographic standards can be purchased or standard sediment discs may be prepared following directions appearing in Standard Methods for the Examination of Dairy Products.[4] In the grading of sediment pads some acceptable standard must be followed and the control official must determine the sediment grade to be used in rejecting milk. In using the sediment test one must realize that it has certain limitations; if these are borne in mind the test can serve a very useful purpose:

> First, it may be merely a measure of the straining or filtering efficiency on the farm. Efficient straining may give one "cleaned" milk whereas what is really desired is "clean" milk.
>
> Second, there is little correlation between sediment and bacterial content. The producer cannot be told that his milk will have a low bacteria count if his sediment test alone is improved. The only valid argument is that dirt in milk, or in any other food for that matter, is objectionable.
>
> Third, the sediment test does not yield results which compare in accuracy with the results of many other procedures in milk control; thus it is best used as a supplement to more exacting tests.

After the test has been run, the producer must be notified of the result. This can be done in a number of ways: the sediment pad may be mailed to the producer; it may be posted on a bulletin board in the milk plant in situations where producers deliver their own milk; it may be taken to the farm by the sanitarian at the time of inspection; or in certain instances it may be delivered to the producer by the milk hauler. If milk is rejected at a plant or receiving station, a suitable tag should be securely attached to the can designating that the rejection was based upon an excessive amount of sediment. Sometimes a small envelope appropriately marked and containing the pad may be attached. Obviously, when farm inspections are made emphasis must be placed upon clean milking methods, not upon more careful straining.

COLIFORM TEST

The coliform test is used to determine the presence of organisms of the coliform group in milk. It is used primarily to detect contamination after pasteurization. Briefly, 10-ml., 1-ml., and 0.1-ml. dilutions of the milk sample are inoculated into appropriate media, incubated for 48 hours at 37° C., and then observed for the presence of gas in liquid media or the presence of typical coliform colonies on solid media. The procedure is quite like that used in the bacteriological examination of drinking water.

Interpretation and field use

The coliform test is based upon the presumption that the number of coliform organisms in milk will be small or absent, at least in high dilutions, if great care has been exercised in processing and handling. The test parallels the agar plate count in certain respects where a low bacteria count is usually indicative of good plant practices. While it has been reported that certain strains of coliform organisms are resistant to pasteurizing temperatures, particularly temperatures in the range 142° to 143° F., evidence is now quite conclusive that these heat-resistant strains are not commonly encountered and that the presence of coliform organisms in pasteurized milk indicates faulty plant hygiene.[7] Multiplication of coliform organisms is favored by conditions conducive to the growth of other bacteria, with storage temperature of the bottled milk one of the significant factors.

The presence of coliforms in large numbers indicates, first, the possibility that the milk was not properly pasteurized, and second (and unquestionably more common) that the pasteurized milk was contaminated by unclean equipment or through careless handling, resulting in post-pasteurization contamination. Pasteurizing vats, valves, pumps, coolers, pipe lines, and bottle-filler valves frequently are the source of coliform organisms. Draining the rinse water from the bottler valves with the hand just before bottling begins may contaminate an otherwise well-sanitized bottler.[29] A line test whereby samples are taken at several points in the processing operation is valuable in locating the source of coliform contamination. The coliform test is making a real contribution toward more careful equipment cleaning and handling methods.

METHYLENE BLUE REDUCTION METHOD

This test involves a determination of the time required for the disappearance of color when methylene blue thiocyanate solution is added to milk. A one-ml. portion of standard methylene blue solution is added to 10 ml. of milk in a test tube. The sample is mixed and then placed either in a water bath or in a warm air chamber maintained at 37° C. Observations are then made at intervals of fifteen or twenty minutes, for an eight-hour period, to determine the time required for disappearance of the blue color in the sample.

Interpretation and field use

The methylene blue test is particularly applicable to milk before it has been pasteurized. The equipment for operating the test is relatively inexpensive and can be readily used by persons without technical training. In general, milk with a high bacterial content will decolorize the dye quite rapidly, whereas milk with a low count retains the blue color for several hours. The following classification should be observed when this test is used:

Class 1. Excellent, not decolorized in eight hours.
Class 2. Good, decolorized in less than eight hours but not less than six hours.
Class 3. Fair, decolorized in less than six hours but not less than two hours.
Class 4. Poor, decolorized in less than two hours.[4]

Results of the test may be effectively used as a basis for improving milk supplies, particularly milk intended for pasteurization. Where this test is used as a regular procedure, producers should be educated to understand the meaning of the "blue test," and sanitary control may be based largely upon the results of it. Field visits should, of course, be made at producing farms when the methylene blue test has demonstrated an inferior quality of milk. This test, coupled with field investigations, serves as a very effective means of correcting improper production methods and raising the general sanitary condition of a supply. For a health department not having access to some of the more exacting laboratory techniques, the methylene blue test is recommended; the sanitarian can conduct it himself with little difficulty.

RESAZURIN TEST

The resazurin test for determining the sanitary quality of raw milk makes use of the chemical indicator resazurin. The procedure is quite similar to that for the methylene blue test except that the incubation time is somewhat less, with results more quickly secured. One tenth (0.1) ml. of an 0.05 per cent resazurin solution is added to 10 ml. of milk and placed in a temperature-controlled water bath maintained at 37° C. Observations for color changes are generally made at fifteen-minute intervals. Color change determines the end point—some investigators feel that a pronounced pink[18] should be selected, while others prefer to use uniform color standards.[47]

Interpretation and field use

The resazurin test is used to determine the sanitary quality of milk and cream, and although it has been used on pasteurized cream, its more common application is with raw milk before it has been pasteurized. Research has indicated that resazurin is more sensitive than methylene blue to physiologically and pathologically abnormal milk. Milk with a high leucocyte count, milk showing mastitis infection, or milk from animals late in lactation is detected quite sharply with resazurin. When a pronounced pink is used as the end point, the reduction time is one-half to two-thirds that required with methylene blue; in fact, a resazurin pink of three hours or longer represents as good a quality of milk as that shown by a five-and-one-half-hour methylene blue test. Milk samples which do not decolorize in three or more hours with resazurin have bacterial counts of less than 400,000 per milliliter; those having a resazurin pink test of five to six hours have corresponding plate counts of below 100,000 bacteria.[18]

In practical application this test may be used for the rather rapid grading of milk, especially where large numbers of samples must be examined. The information derived from this test may be used in much the same manner as information from the methylene blue test. With the resazurin test, however, rapid reduction of the dye may indicate not only a high bacteria count but also milk from animals with mastitis infection. While it must be realized that this is simply a reduction test based on the use of a dye, and that other more exacting tests will reveal a more accurate picture of milk quality, this test has been quite generally accepted and may be used with confidence.

LABORATORY PASTEURIZATION OF RAW MILK

The laboratory pasteurization of raw milk has for its primary purpose the isolation of milk samples which show little or no reduction in bacterial content when pasteurized. Individual producer samples are first examined by the direct microscopic method to determine the bacteria count per milliliter; the samples, in appropriate tubes, are then pasteurized in a water bath maintained at 138° to 140° F. for a period of two hours. At the end of that time the samples are again examined microscopically to determine what reduction, if any, has been effected by pasteurization. This technique does not appear in Standard Methods for the Examination of Dairy Products, but the practical experience of those who have used it indicates that it has definite advantages as a control measure.

Interpretation and field use

Bacteriologists have known for a considerable period of time that some milk shows a marked reduction in bacterial content after pasteurization and that other milk shows very little reduction. As early as 1923 Dotterer[23] reported the presence of heat-resistant bacteria which survive pasteurization temperatures. Within the past few years, and particularly since the culture media used for making agar plate counts has been changed to include a more nutritious type, heat-resistant bacteria have received increased attention because higher bacteria counts have been experienced in pasteurized milk. Organisms which grow at pasteurizing temperatures are known as thermophiles; those which may not grow but which survive the temperature are known as thermoduric organisms. Fabian[25] states that thermoduric bacteria in relation to dairy bacteriology are used to designate a group capable of withstanding the normal range of pasteurization, with either the holding or the high-short method, but incapable of growing at these temperatures. From the standpoint of temperature relationships, the bacteriologist classifies three groups as follows:

	Temperature range		
	Minimum	*Optimum*	*Maximum*
Cryophilic bacteria	32° F.	59° F.	86° F.
Mesophilic bacteria	59° F.	98.6° F.	113° F.
Thermophilic bacteria	113° F.	131° F.	158° F.

Thermoduric organisms seem to have their origin in the production of milk at the farm, some evidence indicating that the udder of the cow is one of the principal sources; for thermophilic bacteria, the holding type of pasteurizer is the chief source of contamination. Thus it appears that thermoduric bacteria are a problem of the milk producer, whereas thermophilic bacteria are mainly the problem of the milk processor. Evidence is lacking to show that these organisms are pathogenic, or that they are of any public health significance, yet they do cause high counts and frequently make compliance with bacterial standards difficult of attainment. Mallmann, Bryan, and Fox[53] have demonstrated that laboratory pasteurization of raw milk for a period of two hours will cause the disintegration and disappearance of non-thermoduric bacteria and that a microscopic examination of samples at the end of the two-hour pasteurization period will represent viable heat-resistant cells. These investigators have suggested an arbitrary standard of 40,000 bacteria per milliliter as indicative of the presence of objectionable numbers of thermoduric bacteria in milk incubated at 58° to 60° C. for a two-hour period. Myers and Pence,[60] after studying the laboratory pasteurization of raw milk, are of the opinion that this method is sounder than the total count method for judging the true sanitary quality of raw milk. In their opinion more emphasis should be placed upon the types of microorganisms than upon the total number, since it has been shown that milk from different farms varies greatly in ability to show reduction upon pasteurization. Furthermore, since the presence of excessive numbers of thermoduric organisms has been found to be directly related to insanitary production methods, the laboratory pasteurization of raw milk has proved a most useful test.

The test is particularly useful to the sanitarian in locating milk showing little or no bacterial reduction upon pasteurization. Farm inspections generally reveal improperly washed milk utensils, especially milking machines, and careless handling of milk. In the milk plant, unclean equipment, re-pasteurization of milk, long and continuous pasteurization, foam, dead ends in piping, and the practice of allowing milk to remain hot in pre-heaters will also contribute to thermophilic contamination.[85] Work done at the University of Illinois has demonstrated that thermoduric organisms can withstand 75 p.p.m. of chlorine for two minutes but are destroyed in that length

of time when chlorine residual is raised to 100 p.p.m. A five-minute exposure to 35 p.p.m. will also destroy these organisms.[24]

This chapter has attempted to present a brief discussion of the numerous laboratory tests that aid the sanitarian in his work. It is advisable that he be well acquainted with them and that they be used to advantage in a well-rounded program in milk control. The latest edition of Standard Methods for the Examination of Dairy Products should be carefully studied for correct procedures involving the testing of milk and dairy products, but current periodicals should also be regularly consulted for the research that is constantly being reported in this field.

X

THE SANITARY CONTROL OF FROZEN DESSERTS

The frozen desserts industry, which consists largely of the manufacture of ice cream, is a business of considerable size in this country. The value of ice cream and frozen desserts and specialties manufactured in 1939 was $319,011,951,[83] and this figure does not include establishments whose production was valued at less than $5,000. The popularity of ice cream is well recognized, with patronage at dairy bars and soda fountains especially heavy during the warmer months of the year. Ice cream is now more than ever looked upon as a nutritious food instead of just a confection. Extensive advertising on a national basis, plus a general improvement in quality, has markedly increased its popularity.

The sanitary control of frozen desserts by health departments has, in general, lagged far behind milk control. This does not indicate a failure on the part of health authorities to realize that the manufacture and sale of ice cream present a potential health hazard; it is attributable, rather, to limited resources and personnel and to the urgency of solving other new sanitary problems. However, records show that ice cream has been indicted on several occasions as the source of disease outbreaks. During the five-year period 1934 to 1938 ten outbreaks were reported as having been conveyed through ice cream—two of typhoid, one of septic sore throat, four of gastroenteritis, and three of food poisoning.[31] These outbreaks represented 8 per cent of the total number reported for that period as having been conveyed through milk and milk products. In 1942 seven outbreaks attributable to ice cream, involving 284 cases, were reported by state and territorial health authorities to the United States Public Health Service.

In 1937 the Committee on Milk and Dairy Products of the American Public Health Association presented a report[2] which recommended in part that trained personnel be supplied within the health departments and within the industry to provide adequate supervision in sanitation and maintenance of ice cream plants. The Committee took the position that the industry as well as departments of health has a direct responsibility in this phase of public health protection.

LEGISLATION FOR SANITARY CONTROL

While many municipalities have regulations governing the manufacture of frozen desserts, the first attempt to promulgate an ordinance that could be recommended for national application was made by the United States Public Health Service. An ordinance was prepared for presentation to a specially appointed Advisory Board in July, 1937, and as a result of the Board's deliberations a recommended ordinance and code was published in March, 1938. Further revision was made by the Board and a recommended "Frozen Desserts Ordinance" was issued in November, 1939. This document represents the advice and experience of leaders both within the industry and in the field of public health. It is recommended for voluntary adoption by states and their political subdivisions. Its main purpose is to encourage uniformity and a higher degree of effectiveness in the sanitary control of frozen desserts. The reader is advised to consult this recommended legislation when considering the adoption of an ordinance for local control.

SOME FEATURES IN SANITARY CONTROL

The manufacturing plant

The sanitary supervision of plants manufacturing frozen desserts does not differ materially from the type of supervision that is necessary in the milk pasteurization plant. The main differences are that for frozen desserts a wider variety of ingredients must be considered, there are certain processing differences, and certain of the machinery for packaging differs mechanically from that used in milk plant operations. Plant construction and maintenance should be at the same high level. Cleaning and bactericidal treatment of containers and equipment can be accomplished in a manner similar to that required for milk. There is one marked difference, however—the proper pasteurization temperature for ice cream mix. The recommended standard is 155° F. for thirty minutes, and it is highly desirable that a standard temperature and time for this important safeguard be fixed. In 1928 Zoller[88] sent inquiries to 500 plants, of which 179 replied. The answers ranged from 140° F. for thirty minutes to 185° F. for ten minutes, with all sorts of intermediate times and temperatures given. Recently, however, the trend has been for manufacturers to

pasteurize at 160° F. for thirty minutes, since certain investigators have shown that protein stability of the mix and shortened freezing time result when higher temperatures are used. Obviously, in order to carefully control pasteurization, proper thermometer equipment must be used; this point has, in fact, been all too frequently neglected in many plants. The sanitarian will find that if the same careful inspection technique is used in ice cream plants as in milk-processing plants, the industry will welcome such aid and be amenable to suggestions for improving sanitation.

The quality of the product

While it is highly desirable to insist that the raw ingredients for ice cream mix be of the same standard required for milk processing, it would seem that, except in a few outstanding instances, this is difficult to attain at present. However, if a product-grading ordinance is in force, such as the one in Memphis, Tennessee, the bacterial quality of the milk used for ice cream, and the ice cream itself, may be graded. The Memphis ordinance considers both the quality of the dairy products used and the sanitary conditions of the manufacturing plant, and allows the sale of Grade A and Grade B frozen desserts. To be graded A or B, the frozen dessert must have been manufactured from milk or milk products meeting the requirements for those grades as established in the Memphis Milk Ordinance.

In addition to the milk and milk products used, the fruits, nuts, coloring, and flavoring added to the mix have a definite bearing on the bacterial content of the finished product. These ingredients are usually added after pasteurization and frequently serve as definite contaminants. Tracy[79] has shown in a survey conducted at the Illinois Experiment Station that 65 per cent of the nut meats collected from ice cream plants supported bacterial growth and that 50 per cent gave a positive test for *E. coli.* Brown[12] demonstrated that *Staphylococcus aureus* and *Eberthella typhosa* inoculated into three different shades of coloring materials survived for a period of two weeks, although their numbers decreased rapidly during the storage period. Work by several investigators, including Brown, Prucha, and Tracy, has shown that there are effective and relatively simple treatments for ingredients used in ice cream so that these do not serve as contaminants:

1. In treating pecan nut meats, dipping in a 50 to 75 per cent boiling solution of sucrose plus one per cent salt, followed by drying in a hot air oven, not only improves the sanitary quality of the meats but markedly improves their flavor. The treated meats should then be stored in glassine bags at room temperature but in an atmosphere where relative humidity is 42 to 50 per cent.

2. Coloring materials can be heated at normal pasteurization temperatures (143° F. for thirty minutes) or up to 180° F. for thirty minutes without injuring the quality of the colors.

3. Strawberries and raspberries can be subjected to normal pasteurization; peaches mixed with sugar can be boiled for three minutes without injuring their flavor; the flavor of oranges is not affected when they are dipped in a 75-to-100-p.p.m. chlorine solution to improve the bacteriological condition of this fruit for use in ices and sherbets.[40]

In addition to these treatments, much can be done in the ice cream plant to protect ingredients from contamination by keeping them under sanitary storage conditions and handling them in a clean manner. Sanitarians should direct more attention to treatment of ingredients used in ice cream, since it is frequently a neglected phase in the manufacturing procedure. They should encourage the adoption of better control measures in the plant so that contamination from this source can be avoided.

Retail handling and dispensing

Retail handling and dispensing largely involves fountain sanitation. One decided hazard to ice cream is the unclean scoop. Krog[40] has shown the effect of the unclean scoop on the bacterial content of ice cream: one hundred samples of ice cream were dispensed in the common manner with an unclean scoop and one hundred other samples were collected with clean equipment. The results are shown below.

	*Bacteria per cc.**	
	Unclean scoop	*Sterile scoop*
Samples from surface	178,000	38,000
Samples from sub-surface	78,000	42,000
Samples of water in which scoop was kept	1,650,000	
Samples from scoops rinsed before and after using and stored on racks		20,000

* Average count of 100 samples of ice cream.

These data are convincing evidence that the condition of the scoop or other dispensing device markedly influences the bacterial content of the ice cream served the customer, and point to the need for educating fountain and food personnel regarding the necessity of either keeping scoops in clean running water or rinsing them in cold running water before and after each use and storing them on a dry rack.

The counter freezer

Another element of sanitary significance in ice cream manufacture, introduced in the past few years, is the counter freezer. It began to appear with frequency about 1929, and installations are now in use in nearly all parts of the country. It has added greatly to the control problem, for it decentralized the freezing of ice cream. With this equipment the retailer buys ice cream mix from a manufacturing plant, adds flavoring, coloring, fruit or nut meats, as he chooses, and freezes the product right on his premises. After freezing, the ice cream is placed in individual quart or pint packages or in regular ice cream cans and stored in a hardening cabinet, usually integral with the freezer. Considerable litigation has been brought by cities, by individuals wishing to install and use counter freezers, and by companies manufacturing them.[40] Legal proceedings frequently followed when a health department refused to permit their use on the grounds that they did not comply with local frozen desserts ordinances. In 1936–37 the Alabama Supreme Court upheld the City of Birmingham in its requirement that "ice cream or other frozen substances, composed in whole or in part of milk or milk products, shall be pasteurized . . . and shall flow or be conveyed through appropriate pipes or conveyors from the pasteurizing apparatus directly into the freezing apparatus. . . ."* By another provision of the Birmingham ordinance, ice cream manufactured by any other method is condemned as insanitary and its manufacture and sale prohibited. Since it was not feasible for a counter freezer operator to comply with the provisions of this ordinance, the use of the counter freezer was virtually prohibited in that city. In Baltimore, Maryland, a city ordinance requires pasteurization of the mix at the place of freezing.

In many other places counter freezers are permitted provided they

* Laws Governing the Production, Handling, and Distribution of Milk and Milk Products, Birmingham, Alabama, 1944.

meet stipulated sanitary requirements. These requirements should be reasonable and yet give essential protection to the product. Some regulations require an impervious floor in rooms where counter freezers are installed; others allow the use of tight linoleum over a smooth wood floor. Walls and ceiling are required to have a smooth, washable, light-colored surface. The counter freezer should be installed preferably in a separate room. However, since this is not always possible, glass partitions may be erected at the front and sides with a canopy or similar covering overhead and an opening only on the side farthest from the public. Lighting of the room should comply with acceptable standards, with a minimum recommended standard of ten foot candles of either natural or artificial light. Another very necessary provision is one contained in the recommended Frozen Desserts Ordinance of the United States Public Health Service: this requires that all mix not frozen at the plant where pasteurized be transported to the place of manufacture or freezing in sealed containers, and that the mix be handled in a sanitary manner.

Furthermore, it is necessary that hand-washing facilities be provided in the freezing room. A lavatory properly connected with the plumbing and supplied with hot and cold running water, soap, and approved sanitary towels must be part of the equipment. Facilities for cleaning freezer parts, cans, forms, piping, and other equipment are also necessary. The vats or wash tanks should be of sufficient size to accommodate the equipment to be cleaned. Either water at 170° F. or steam under pressure is required for sanitizing purposes; or provision must be made for sanitization with a hypochlorite solution of at least 100 p.p.m. Another necessary provision is that the freezer be flushed with a chlorine solution of at least 50 p.p.m. just prior to use. Wiping any contact parts of the freezer with a cloth after bactericidal treatment is prohibited. In one recommended ordinance, in effect in Lansing, Michigan, the following additional provision is made: "All mix shall be pasteurized and only a sufficient amount placed in each container for one freezing. The mix shall not be held longer than seven days and then only under proper refrigeration. All finished products shall conform in all respects to the legal requirements of the board of health and shall be properly refrigerated at all times."[41] If regulations or an ordinance governing the maintenance and operation of counter freezers contain the general provisions as

noted herein, and if sufficient supervision of installations is made by the sanitarian, it is believed that a safe and wholesome product will result. However, for purposes of clarity, where such local requirements are in force all companies and local jobbers offering counter freezers for sale and all manufacturers supplying mix should be given copies of such regulations and no installation should be approved until all provisions are fulfilled.

Bacteriological standards

Bacteriological standards for mix and for the finished product differ among the states. Those states having standards have rather generally adopted counts of 100,000 bacteria per cubic centimeter or per gram as the maximum allowed. Experience in most communities indicates now that in general the industry is putting out a product considerably below this figure. Package samples taken directly from plants show counts well within a limit of 25,000 bacteria per gram, and it appears that in well-operated plants a standard ranging from 25,000 to 50,000 is readily attainable.

That more attention by health departments should be directed to supervision of the frozen desserts industry is a foregone conclusion. It is especially essential that more attention be paid to the manner in which frozen desserts are handled and dispensed in retail establishments.

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XI

THE FOOD CONTROL PROBLEM

Food control may be defined as those measures instituted by federal, state, or local governmental agencies to assure that food is of such quality and is prepared, distributed, and dispensed in such a way that the health of the consumer is protected and promoted. Broadly, such control is concerned with food from the point of production to the point of final consumption. A great deal could be written about the types of control exercised by various governmental agencies; however, for the purposes of this book it seems advisable to mention only briefly the work of these agencies in order to permit detailed discussion of individual control problems.

FEDERAL, STATE, AND LOCAL INSPECTION

Foods and food products involved in interstate commerce are inspected by the Food and Drug Administration of the Federal Security Agency. The agency operates under authority granted by the Federal Food, Drug and Cosmetic Act, which was enacted by Congress in 1938 and which superseded the original Food and Drug Act of 1906. The broad objective of the 1938 act is "to prevent the manufacture, transportation, handling, holding and selling of adulterated or misbranded food, for the purposes of safeguarding the public health and preventing deceit upon the purchasing public."[17]

State food control agencies are found in all of the forty-eight states. In twenty-one states enforcement is vested in the state department of agriculture; in twenty states, in the state department of health. In the remaining states enforcement is vested in the state laboratory or is the responsibility of the food commissioner, state chemist, and so on. In general, food control at the state level follows quite closely the type of work carried on by federal authorities, although not all state legislatures have amended their pure food laws to meet the standards and provisions of the Federal Food, Drug and Cosmetic Act of 1938. In several states food regulatory work and the activities of the food agency are affected by laws designed to promote the sale of and give close supervision to agricultural food products originating in the state. As a result, some of the public

health aspects of food control such as sanitary processing and purity of foods have been neglected.

While many of the larger cities have ordinances empowering the health officer to detain, confiscate, or condemn any food which is impure, adulterated, or deleterious to health, the local department's greatest activity is concerned with the sanitary control of retail food-handling establishments to prevent food poisonings, infections, and the spread of communicable disease through food. In this category are food and drink establishments ranging from the corner lunch stand, grocery store, tavern, club, soda fountain, carnival and fair stand, to the hotel kitchen, hospital food department, and school and industrial cafeteria, all of which must be inspected and supervised if satisfactory standards are to be encouraged and maintained.

The local enforcement official is concerned not only with the sanitary quality of food and drink prepared but with such matters as suitability of premises and equipment, dishwashing, water supply, refrigeration, food protection facilities, food-handling practices, waste disposal, and housekeeping methods. To carry on an effective program the food control official must make use of the combined sciences of bacteriology, chemistry, public health engineering, epidemiology, toxicology, and statistics.[29] In addition, he must develop and use certain educational techniques so that the public health reasons for fundamental requirements will be better understood by persons engaged in the food business. The multiplicity of factors entering into the sanitation of retail food outlets encompasses a public health problem of considerable proportions, a problem which until relatively recent years has not been given the attention or the scientific study it deserves. Although much of the material in this text is applicable to all types of food establishments, discussion of food control will be confined largely to the sanitary supervision of establishments which dispense and sell food mainly for consumption on the premises. For the broader aspects of the food control picture, including technology and the relationship of food to the public health, the reader is referred to books listed in the Appendix, page 249.

IMPORTANCE OF THE PROBLEM

The exact number of food-borne outbreaks, cases, and deaths occurring in the United States at any one time is not known. While the

United States Public Health Service compiles and tabulates data annually on food-borne outbreaks reported by state and territorial health officers, reporting is done mainly by those health departments which make epidemiological investigations and take active interest in the problem. Many small outbreaks go unnoticed, and are therefore never investigated or reported. Consequently, any attempt to quote statistical data for the country as a whole has relatively little point. However, data assembled by health departments in certain cities where careful investigation is carried on readily convince one that the incidence of food infections and intoxications is higher and of much greater public health significance than published tabulations indicate. Even the incomplete figures at hand are sufficiently convincing to emphasize the need for more concentrated effort on the part of health authorities to train food handlers and to remove as many of the imperfections and unsatisfactory practices surrounding the handling of food as possible.

Within the past decade or two the public eating establishment has become an increasingly important factor in public health, while the home kitchen and dining room have assumed diminishing importance. Such factors as increased travel, population shifts, changes in living habits, and the employment of women in industry may be given as reasons for changed eating habits on the part of the public. The magnitude of the problem is apparent when it is realized, for example, that in the United States there are over 160,000 food establishments such as restaurants, cafeterias, lunchrooms, and soft drink and ice cream stands; over 80,000 drinking places which serve meals, and about 50,000 taverns, bars, clubs, and so on not serving meals; and nearly 40,000 drug stores with soda fountains.[46] According to one commercial agency,[11] seven million persons eat at least one meal a day at fountain lunch counters and over twenty billion meals are eaten annually in restaurants and other public food establishments. In addition, thousands of people are fed daily in industrial and school cafeterias, boarding houses, college dining halls, institutions, and on planes and trains en route. The sanitary control of public food service is therefore a health problem of major proportions and a challenge to health departments to see that acceptable standards of sanitary practice are achieved and maintained.

XII

ESSENTIALS OF FOOD ESTABLISHMENT SANITATION

THE basic principles of food establishment sanitation require that the customer's health be protected against contaminated foods and communicable disease organisms. How well the patrons of public food and drink establishments of all types are protected depends upon how well an establishment, whatever its size, conforms to the sanitation points enumerated below:

1. The safety of the food and drink served
2. The personal hygiene and food-handling practices of the food worker
3. The safety of the water supply
4. The sanitary disposal of sewage and water-carried wastes
5. The protection of food from contamination during processing, display, and storage
6. The washing, sanitizing, and storing of utensils and equipment
7. The sanitary maintenance of the premises, including general arrangement and upkeep, refrigeration, light and ventilation, toilet and handwashing facilities, housekeeping practices, and the disposal of garbage and refuse

In this chapter a discussion of each of these factors will be based primarily on their public health value.

SAFETY OF THE FOOD

The wide variety of foods available to the public today, plus the fact that the point of production may be far removed from the place of final consumption, complicates the control problem to a considerable degree. On the other hand, a great deal of protection is afforded the general food supply through activities of both federal and state control agencies, whose vigilance prevents the sale of adulterated and impure food that might otherwise enter the channels of trade. The local sanitarian derives real benefit from the work of these agencies, but it is he who represents the last line of defense against contamination of the ultimate consumer by impure food. At a local level, whether city, county, or district, the sanitarian is directly concerned with con-

tamination introduced during local storage, preparation, or display, with spoilage, and with such other factors as faulty or excessive handling which may render the food unsuitable for human use. Finally, he must investigate outbreaks of food poisoning and strive to control conditions contributory to them. Such control requires immediate action of a regulatory or condemnatory nature and can be accomplished more effectively through a local agency.[42]

There are certain considerations which should aid the sanitarian in judging the safety of food and drink sold through the several types of public food establishments:

First, the source of supply. If the food has been shipped from another locality, the question arises: Has it been produced, processed, packaged, transported, and handled under the supervision of another health agency? This is particularly applicable to fruits and vegetables, meat, dairy products, and shellfish. Such supervision does not necessarily presuppose that the food is wholesome upon arrival, since it may have spoiled or become contaminated in transit or while held by the retailer, but it does indicate that some control has been exercised at the point of origin.

Second, the age of the food. Obviously, if the food has been held or stored for an unusually long time or has been improperly stored, the likelihood of spoilage is increased. In this case it is well to examine weigh bills and invoices to confirm dates of shipment and receipt, and to obtain as much information as possible concerning the age and history of the food.

Third, the appearance of the food. Generally, if food is abnormal in appearance, texture, or color, or if it has a decomposed odor, is obviously contaminated with a foreign substance or with infectious material, is adulterated, or contains dirt or other extraneous matter, its use must be immediately prohibited. It frequently happens that there is little question about the unfitness of a particular food, in which case such food must be condemned. However, if physical inspection alone does not suffice, and there is doubt concerning the condition, a chemical or bacteriological examination, or both, should be made and the food tagged and placed under detention until laboratory results either confirm or deny organoleptic findings. Ordering food withheld from sale is a meritorious procedure in that it protects the public, the owner, and the sanitarian alike, and delays sum-

mary destruction or condemnation of food at least until definitely declared unfit.

It should be pointed out, however, that in many instances the appearance of food is deceiving. Infection of food with certain bacteria, such as *Salmonella* and staphylococci, cannot be detected by organoleptic tests; on the other hand, aged meat, "high" poultry or game, and certain cheeses may be cited as examples of food not wholesome in the organoleptic sense yet still safe to eat. Therefore, the history of the food under inspection must be ascertained; if there is still any doubt, detention under proper refrigeration to prevent further spoilage should be arranged until further evidence has been accumulated toward a final decision as to disposition. When food samples are taken, the following points should be kept in mind:

1. A duplicate sample must be given the owner of the food; the sample should be sealed in the presence of the owner and a witness.
2. An ample and representative sample must be obtained for the examination.
3. The sample must be transported to the laboratory without delay and kept iced, if perishable, during the entire period of transporting.
4. Sampling equipment and containers must be sterile and known to be free from the suspected contaminant.

Certain conditions make it necessary to condemn or place food under detention even though no spoilage or adulteration is apparent. Such action may be applied to any of the following items, provided, of course, that local ordinances permit.

1. Meat or meat products from an uninspected source. Where a meat inspection ordinance is in effect locally, all meat and meat products shipped in from outside sources must meet equivalent local standards. Such meat or meat product of unknown origin should be condemned. As a matter of fact, it is not possible to make a complete inspection of a meat carcass to determine freedom from disease unless the viscera, such as lungs, liver, kidneys, and the head are available. Court action may then be instituted against the owner of the meat for local ordinance violation.
2. Milk, cream, or ice cream from a source not approved by the local jurisdiction, or handled and dispensed within the establishment in such manner that contamination has resulted. In communities where the milk ordinance requires that an expiration date for the sale of milk be printed on the cap, out-of-date milk may be condemned if so stated by ordinance or law; otherwise, detention is preferable and the milk ordered returned to the dairy for processing into manufactured products. "Dipped milk"

or milk so stored that bottles are submerged below the level of the cooling water may be condemned, since both practices subject milk to contamination. When state laws or local ordinances require ingredients to be pasteurized, ice cream known to be made from unpasteurized products may be condemned.

3. Candy, cereal, and baked goods, when there is visible contamination or contamination disclosed through laboratory procedures. Candy and baked goods are frequently displayed without proper protection, although this practice is prohibited in most food ordinances. Such foods, when improperly protected, may be condemned if so specified by law or ordinance. The presence of rodent hairs or excreta, insect fragments, and similar substances can now be detected by improved microscopic examination. Bakeries, candy manufacturing plants, and cereal storage houses are notoriously infested with a variety of insects and other types of small animal life. Confirmation of the presence of such contamination in the food is sufficient cause for condemnation.

Custard-filled pastries such as cream puffs and éclairs may be condemned if a local ordinance requires reheating or pasteurization of the filling and there is evidence that such has not been done. (See Appendix page 268 for re-baking procedure.)

4. Seafood and shellfish, either salt-water or fresh-water, which show spoilage or decomposition. (See pages 257 and 263 for signs of and tests for decomposition.) In connection with shellfish, only fish from approved sources should be used. In many communities local laws prohibit the sale of shellfish not from approved sources; obviously, when such local requirement is in effect shellfish from unauthorized sources must be condemned. The United States Public Health Service periodically issues lists of dealers, by name and state license number, certified by state health departments whose shellfish sanitation control measures are endorsed by the Public Health Service. These lists are furnished to state health authorities, to health authorities of all cities having a population of 25,000 or more, and to other interested persons or agencies. Shell stock shipments of interstate shippers are required to be labeled with the initials of the state and the shippers' certificate numbers. Shucked oysters, clams, and mussels shipped from one state to another are required to be packed in non-refillable containers and identified by the initials of the state in which packed and the initials of the original packer-shipper. The purchaser should make sure that the container is sealed and that it bears the initials or abbreviated name of the state and the dealer's certificate number. The inspector should check the number against the lists of certified dealers.[47]

5. Pork or pork products not properly cooked or processed. For example, cuts of roast loin of pork appearing pink in color cannot be considered properly cooked or safe for consumption.

6. Foods contaminated by leakage from overhead waste or sewer lines or from flooding of floors due to sewage backflow, or by poisonous chemicals.

7. Canned goods which are swelled, bulgy, perforated, or imperfectly sealed. In a properly sealed can the ends are concave and not spongy when pressed. However, acid foods and such foods as prunes, molasses, and those packed in heavy syrup may swell without being hazardous to the consumer. Testing by dropping the can on a hard surface so that a portion of the periphery is jarred will bring out the puffing if it is an incipient swell.

8. Poisonous animals and plants. These include mussels served during the summer months; wild rabbit (because of danger of tularemia from handling or from insufficient cooking); certain fresh water fish, particularly pike and perch, which, when not properly cooked, may infect man with encysted larvae which develop into a tapeworm in the small intestine; greenish sunburned potatoes or sprouted ones not deeply peeled, causing poisoning from a toxic substance called solanin; rhubarb leaves and poisonous mushrooms. Some of these foods may not be commonly encountered, but when they are found their use should be prohibited.

Certain field procedures can be used to advantage as screening tests in determining the fitness of various foods. These are not intended to supplant more critical examinations made in a laboratory but are designed, rather, to assist the sanitarian organoleptically. Directions for conducting some of these tests will be found in the Appendix, pages 257–260.

PERSONAL HYGIENE OF THE FOOD WORKER

Although complete knowledge of the amount of illness caused by persons who handle food is, obviously, lacking, a food-borne outbreak serves as a vivid reminder of the important part food handlers play in the everyday operation of the public eating establishment. Food establishment inspection generally has not placed sufficient emphasis on the personal habits and practices of those who prepare and serve food. Even casual observation will disclose a general lack of appreciation of reasonable sanitary safeguards on the part of the average food handler. In fact, relatively little training or experience is ordinarily required of a person wishing to secure employment as a waitress, waiter, or dishwasher, whereas those applying for jobs as plumbers, barbers, beauticians, and morticians, for example, are required to have a license. The solution of this problem is not readily

apparent, although it would seem that vocational training and health information gained through food-handler schools offer a partial solution (see Chapter XIII and Appendix page 271 for suggested courses of instruction for food handlers). At one time health authorities felt some security in the mandatory physical examination requirement,[8] but this has proved to be of relatively little value in reducing the incidence of food-borne disease or in promoting more careful food-handling methods.

The principles of good personal hygiene are well established and there is little controversy about them. Their application to the food business is readily appreciated, but there still remains the problem of having the food handler conscientiously practice them. There are at least three factors operating against the careful handling of food: first, as those familiar with food sanitation can attest, there are certain individuals who are by nature or temperament unfit to handle food; second, there is a rapid turnover in personnel, making for unstable employment and insufficient training; and third, the food handler is under stress, particularly at meal time, in his attempt to give quick service, a situation which contributes to carelessness. Although these conditions must be faced realistically, they are not insuperable, and the sanitarian must make it his job to give counsel and to explain and teach good food-handling methods.

If suitable progress is to be made in correcting the numerous sanitary deficiencies found, food-handling personnel must be enlightened and urged to cooperate. The following points should be stressed:

Hand cleanliness

Above all, the food handler must be trained to keep his hands clean. Proper washing of the hands before beginning work with food, after using the toilet, and after contamination from coughing or sneezing is of the utmost importance. Hands contaminated with discharges from the mouth, nose, throat, and gastrointestinal tract can be a menace to the public health. The fingernails must be kept neatly trimmed and free from dirt at all times. To wash the hands thoroughly, hot running water, soap, a nail brush, and ample time are necessary, and the management must be required to provide these. Hand-washing signs of a type shown in Figure 34 should be conspicuously displayed in toilet rooms and in work rooms.

Courtesy Baltimore City Health Dept.

Figure 34. A good type of hand-washing sign

Health

Persons with colds, sore throats, nausea, vomiting, abdominal pain, diarrhea, or skin eruptions such as boils or infected cuts should not work with food. An acute cold, with attendant coughing and sneezing, can expose food to droplet and hand contamination; any skin eruption containing even minute quantities of pus can subject foods, particularly custard fillings, baked ham, and cold pressed meats, to infection. Close observation of food handlers by the sanitarian is recommended, and any person with even suspected symptoms of disease should be questioned and temporarily suspended from work, at least until he has been released as non-infectious by the health officer or by a physician designated by him when such legal authority can be applied.

Clothing

Clean, washable, light-colored outer garments should be worn by the food worker. All workers, including dishwashers, bus boys, and kitchen help, should wear a clean apron, coat, frock, or uniform. Street clothing is unsuitable because it may be contaminated by contact with persons in the home and on the outside and may serve as a source of contamination to food, dishes, and utensils; besides, it often is not of the type that can be easily laundered.

Head covering

Hair nets, caps, or bands designed to keep the hair in place should be worn by food handlers. Possibly this requirement has more aesthetic than sanitary significance, but hair in food is disgusting and the requirement is practical. Such protective covering should be arranged so that there is no temptation to brush the hair from the face with the hands.

Food-serving practices

This item involves a large variety of common and improper handling methods, several of which may be cited here: handling food with fingers rather than with appropriate utensils—butter patties without a butter fork, chipped ice or cubes without a scoop, pastries without tongs or without covering fingers with individual pieces of waxed paper; holding glasses by the rim instead of the bottom or side; holding silver by the wrong end; holding clean containers with

the fingers inserted inside; wiping cutting knives on a soiled apron; licking fingers and then handling food; using a side towel first to wipe away perspiration and then to handle dishes or food containers. Such practices are not easily overcome, for they seem rather ingrained, perhaps the result of a habit of following the path of least resistance or a lack of proper instruction. Epidemiologically some of them may not be of great significance, but common-sense rules of sanitation would seem to dictate otherwise.

Horwood and Pesare, after a survey of eating establishments in a large eastern city in 1941, summed up the situation quite tersely when they stated: "The abysmal ignorance of many lay people of the simple requirements of acceptable sanitary practices and good personal hygiene is convincing evidence of the importance of educational procedures in public health engineering activities."[25] Fortunately, this whole problem of personal practices is now more fully appreciated, many health departments having already adopted educational programs to enlighten the food handler and show him better methods (see Chapter XIII). Further, some value may accrue from placing posters similar to the following in food establishments:*

A FEW DON'TS FOR RESTAURANT EMPLOYEES TO REMEMBER:

1. Don't go on duty with a severe head cold, sore throat or any acute illness.
2. Don't cough or sneeze in your hand; use a clean handkerchief.
3. Don't report for duty if you have any skin infection or sores. . . . Consult a doctor.
4. Don't leave the toilet room without thoroughly washing your hands. . . . Keep nails trimmed and clean.
5. Don't pick at the nose, face or fingernails.
6. Don't work without hair nets, caps or bands.
7. Don't lick your fingers while working with food.
8. Don't taste food from serving or cooking spoons or forks.
9. Don't wipe your hands on uniform or apron. . . . Use a clean towel.
10. Don't work in street clothes while handling food.
11. Don't touch the rim or inside of cups and glasses. . . . Handle silver by handles.
12. Don't fail to keep your food handler's card in force. Correct methods are important to you and to the public.

Do YOUR part to protect HEALTH on the Home Front!

* Issued by the Flint, Michigan, Department of Public Health.

Finally, this entire phase of food sanitation must be approached with a sympathetic attitude. Many persons handling food have meager educational backgrounds, and long technical explanations will avail very little; but a common-sense approach on the basis of decency and practical application will generally obtain the results desired. The point should be emphasized that promiscuous fingering of foods and containers is usually evident when food-poisoning outbreaks occur.

SAFETY OF THE WATER SUPPLY

The water used in public food establishments must, of course, be of safe, sanitary quality. It must be accessible to all rooms in which food is prepared or utensils and food containers are washed, and it must be adequate in quantity. In communities served by an approved municipal supply the matter of providing safe water for the public eating establishment is not a serious problem, but in places where the source of water is from private supplies, critical inquiry must be made. The sanitary quality of the water and the location, construction, protection, and maintenance of the private supply must meet the requirements of the state health authority. Regulations governing the protection of private systems promulgated by the state health authority should of course be carefully followed and used as a basis for recommendations. However, because water may be contaminated through improper connections or by insanitary methods and faulty equipment used for dispensing it, the following facts should be borne in mind:

First, there must be no cross-connections with unapproved supplies. Furthermore, a careful survey must be made to see that there are no interconnections between waste and water supply lines. The sanitarian should note any fluctuations of water pressure, particularly in buildings of two stories or more or in buildings where other business demands a large volume of water.

Second, if a drinking fountain is used in the establishment it must be of an approved angle jet type with protected mouthpiece.

Third, ice used in drinks or coming in contact with food must be from a sanitary source. The storage of ice, chipping, crushing, filling of containers, and dispensing must be done in a sanitary manner. The ice should be washed before preparation or serving.

Fourth, if any water other than that supplied the establishment from its own or another approved source is used, the source and potability of such secondary supply must be assured. Some hotels, for example, purchase bottled water for restaurant table service—the sanitarian should be satisfied that the source of such water and the methods used to bottle and transport it are satisfactory.

SANITARY DISPOSAL OF SEWAGE AND WATER-CARRIED WASTES

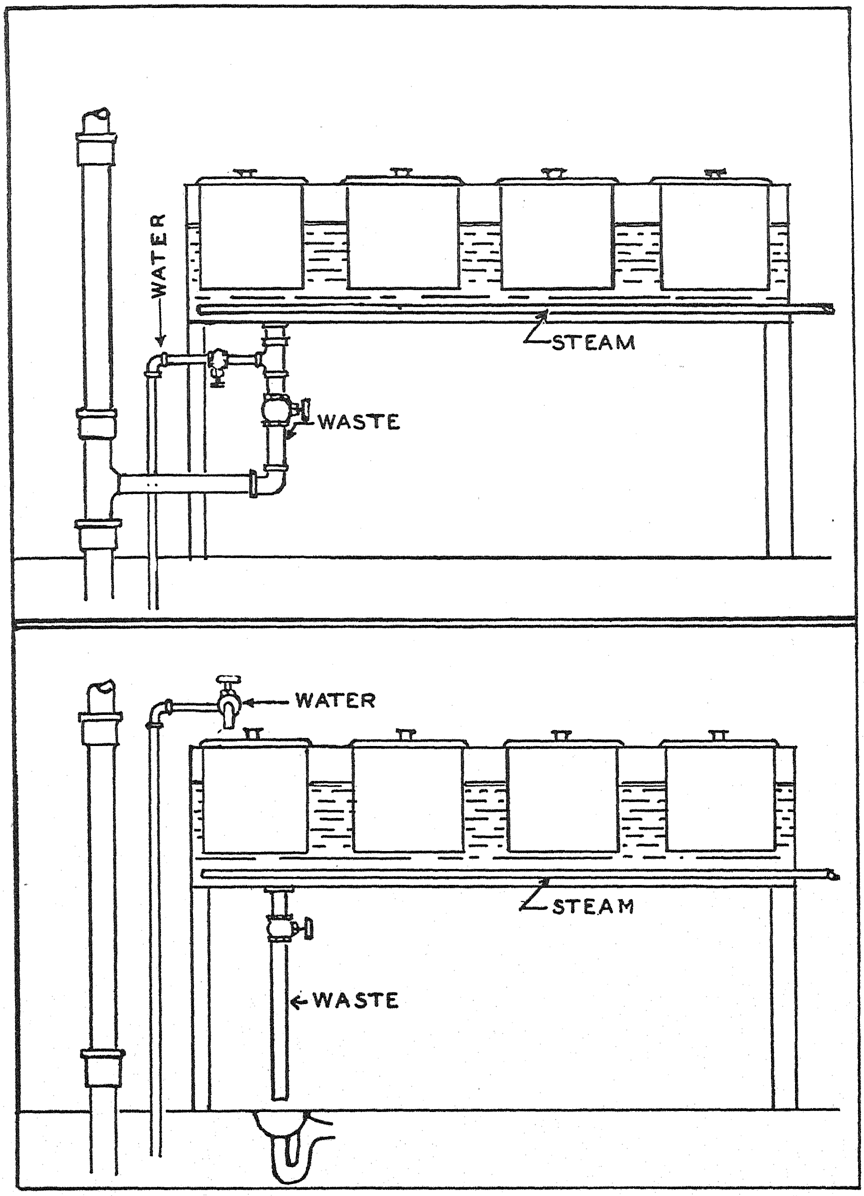
Methods for the disposal of sewage and liquid waste must of course meet recognized state or local standards. The general principles of satisfactory sewage disposal can be readily applied to the public food establishment, but there are considerations relating to the disposal of water-carried wastes which have special importance for food establishments and which should be mentioned briefly:

First, the danger of contamination of the water supply through interconnections and back-siphonage. Some examples are submerged inlets on steam tables (Figure 35), sinks (Figure 36), glass rinsers, and ice cream dipper wells. Because of the danger of sewage backflow and subsequent contamination of food and drink, drain lines from refrigerators should not be directly connected with a sewer.

Second, the improper installation and use of grease traps connected to waste lines from sinks and dishwashing machines. Although a properly maintained grease trap will help prevent waste lines from becoming clogged with grease, proper installation in the first place is necessary (see Figure 37).

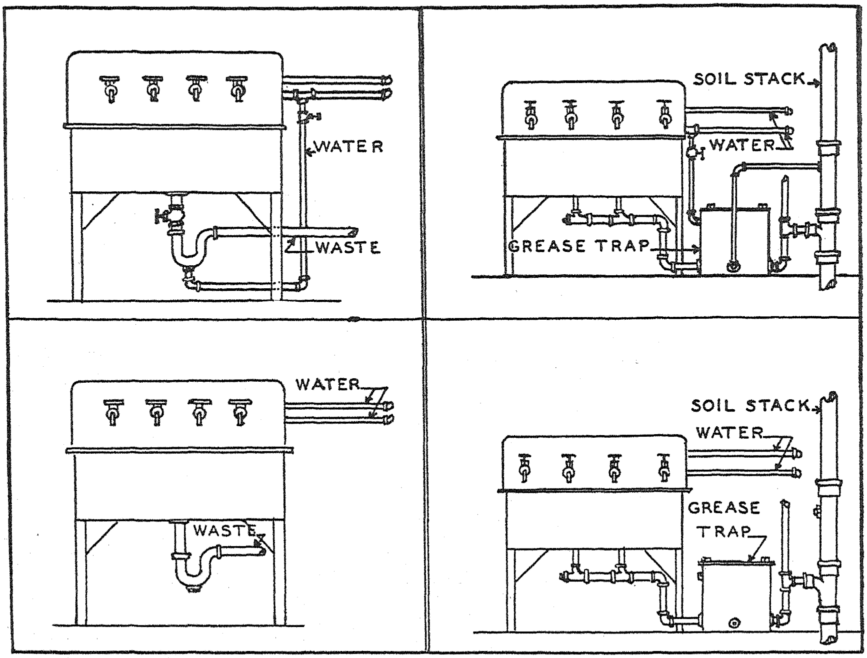
Third, the danger to food or food equipment by leakage from waste or sewer lines suspended from the ceiling in a kitchen or baking or food storage room, or waste from a slop sink, for example, located above a work table or food storage cabinet. Situations of this nature may sometimes be observed in basement kitchens and in other rooms below grade level.

There are innumerable instances of food establishments whose plumbing and equipment installations present a potentially dangerous situation, and with some few exceptions a relatively small amount of work has been done to eliminate them. This phase of food establishment sanitation alone deserves more than passing consideration so



Courtesy Minnesota Dept. of Health

Figure 35. Steam table installations: top, insanitary, with submerged water inlet; bottom, satisfactory installation



Courtesy Minnesota Dept. of Health

Figure 36. Sink installations: upper left, direct water connection to waste line; lower left, correct installation; upper right, direct water connection to grease trap; lower right, condition corrected

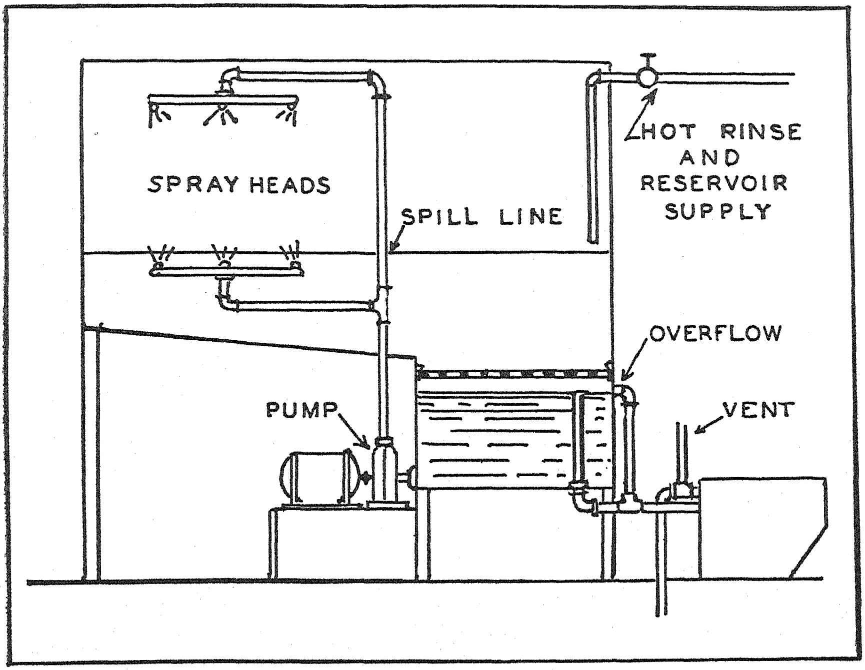
that remedial measures can be instituted both with equipment manufacturers and with local tradesmen who make installations.

PROTECTION OF FOOD FROM CONTAMINATION

The ways in which food may become contaminated are many and varied. The main purpose here is to point out certain defects in operating methods and certain hazards which may subject food to contamination. Contamination of food through faulty handling has already been discussed in this chapter; for present purposes, therefore, discussion of contamination will be limited to factors other than those attendant upon handling. The sanitarian must be able to deal with the following causes of food contamination:

Food displays

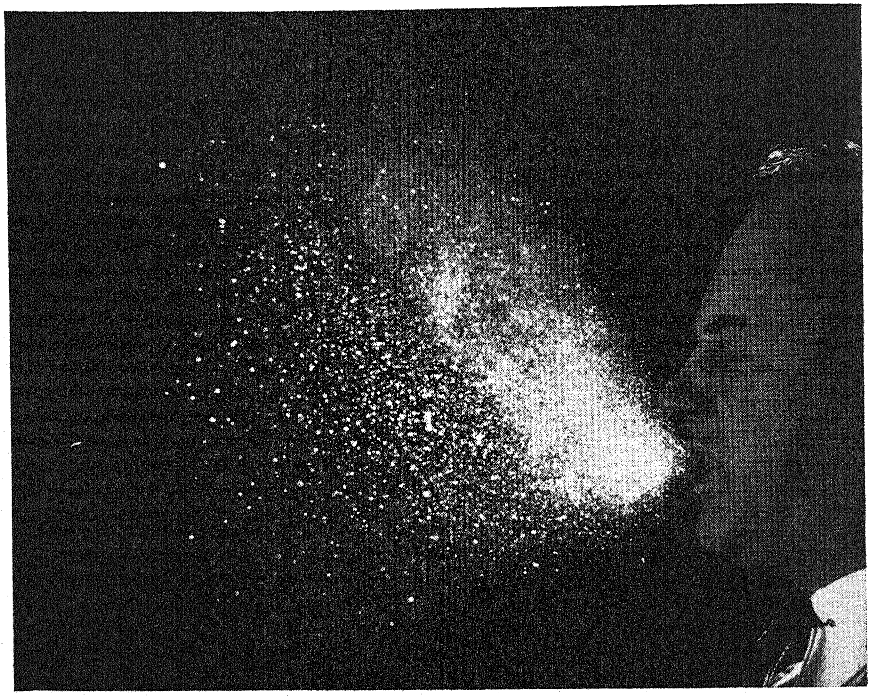
Open displays of food subject the food to droplet contamination from persons coughing, sneezing, and even laughing and talking.



Courtesy Minnesota Dept. of Health

Figure 37. Sanitary dishwashing machine installation

Work done at the Massachusetts Institute of Technology has clearly demonstrated the possible danger to uncovered and unprotected food from this source. Figure 38 shows the amount of material sprayed from a person's mouth and nose when sneezing. Large droplets may be expelled to a distance of twelve feet, but the majority do not travel more than two or three feet. In a violent, unstifled sneeze the number of droplets leaving the nose is insignificant compared with the number expelled from the mouth. Some droplets fall to the ground; others evaporate, leaving bacteria in the air to be disseminated by air currents.[27] Bakery goods, cold cuts of meat, salads, relishes, candy, confections, cookies, cheese, and other products not washed, peeled, or cooked before being consumed are particularly vulnerable to this type of contamination, to handling by customers, and to dust. When such goods are displayed they should be kept under glass or under the newer transparent plastic materials now frequently used in display cases. Cellophane or waxed paper laid over food cannot qualify as satisfactory, since such covering gives no permanent protection, it



Courtesy Dept. of Biology and Public Health, Massachusetts Institute of Technology

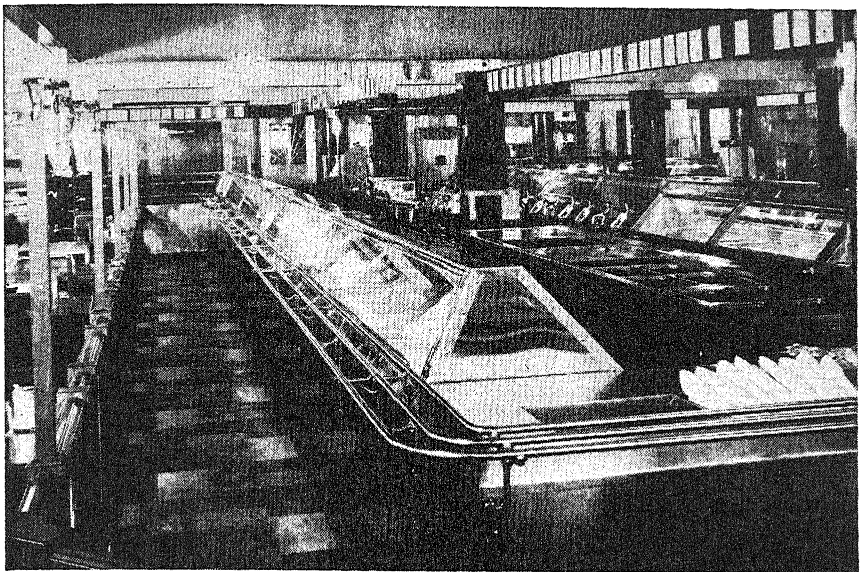
Figure 38. The amount of material sprayed from the mouth and nose of a person during an unstifled sneeze

can be easily pushed aside, and insects, particularly flies, can get to the food beneath. The ordinary cafeteria is by no means exempt from this requirement. Fortunately many are now being provided with glass enclosures which protect food from customer contamination (Figure 39), but the large majority still display their wares without benefit of protection. Promiscuous open food displays are a constant problem and the sanitarian is justified, after he has given due warning, in taking action against habitual offenders.

Insects

What has already been said about protecting displayed foods has equal application to their protection against insects, particularly the fly and the cockroach.

The common fly. The hazard to food from the germ-laden fly is well known and certain methods of control have already been discussed



Courtesy Forum Cafeteria Systems

Figure 39. Cafeteria with glass-enclosed food-serving and display counters

in Chapter III in relation to milk. As previously indicated, control requires the elimination of conditions conducive to the breeding and attraction of flies. Keeping the yard or alley free of garbage, soiled papers, empty tin cans, bottles and broken glass, storing such waste properly until collected, and providing clean, sound metal garbage cans fitted with tight metal covers are important steps in reducing the fly hazard. Many food operators spend sizable sums on expensive fly sprays and spraying machines and neglect correcting situations that attract flies. The installation of screens over all openings (except for premises which are air-conditioned) during the season of the year when flies are prevalent, as well as a regular schedule of treatment to remove those that gain entrance, is obviously beneficial. Any food ordinance requirement dealing with fly control should specify proper screening and also permit the use of other equally effective methods such as fly-repellent fans. (See Appendix page 285 for detailed discussion of DDT as an insecticide.)

The cockroach. The cockroach, of which there are several species in this country, is a distinct problem in the food industry. Besides being pests, cockroaches impart a disagreeable odor to food and to premises where they are numerous. In addition, they can disseminate

pathogenic organisms mechanically as they run about over food and dishes. Some work, though rather meager, indicates also that disease organisms may be carried in the insect's digestive tract. The domestic roach will feed on nearly any article of human food and will gnaw book bindings, woolen goods, and leather. Cockroaches may be introduced into a food establishment on beverage cases and other delivered goods, or they may migrate from one building to another. They are nocturnal in their habits, preferring to hide during the day and come out to feed at night.[15]

The primary control measure is scrupulous cleanliness (good housekeeping practices). This means thoroughly cleaning kitchen and equipment so that no scraps of food remain and keeping food apparatus free of grease and food soil. In addition, food must be properly stored so that it is inaccessible to insect pests. Relatively few roaches will be found in a well-kept establishment, for roach control is directly allied with good sanitary practices.

Supplementary control measures (unfortunately the ones most frequently employed) consist largely in the use of roach powder. Sodium fluoride is one of the most effective, but it is poisonous and great care must be exercised in its use. In fact, in several communities regulations have been enacted requiring that it be tinted. The powder is placed in cracks, crevices, along baseboards, under equipment, and in such other places where roaches run and hide. It should not be dusted on work tables, sandwich boards, or meat blocks where there is likelihood of contaminating food. Pyrethrum may also be used as an insecticide. It may be mixed with sodium borate alone or with borate and flour: five parts flour, three parts sodium borate, and one part powdered pyrethrum, or equal parts borate and pyrethrum. Entrances to cockroach nests can sometimes be located with a flashlight at night by watching the young ones go in and out. When found, the openings may be stopped up with putty or plaster.

DDT is effective in the destruction of cockroaches. Where a 5 or 10 per cent powder is applied at regular intervals, control is quite satisfactory. In damp places where powders are not effective, DDT as a residual spray may be applied behind baseboards, cabinets, equipment, and other places where cockroaches hide. The initial application tends to disturb the roaches so that they scatter out over the premises, but DDT over a prolonged period will give a kill. (See

Appendix page 286 for more details on the preparation of DDT sprays.)

The quickest and most effective remedy for roach infestation is fumigation with hydrocyanic acid gas. This gas, because of its extremely lethal properties, must not be used by anyone but an experienced person, preferably a trained and licensed pest control operator. There is practically no danger to food from the gas as used in this type of fumigation, and when efficiently done it will rid premises of all insect pests.

The ant. Many species of ants, attracted by food, become pests in and around food establishment kitchens. Measures should be taken to render food supplies inaccessible to them. The most common method of controlling ants is by poisoning. A slow-acting poison such as the following is effective:[35]

Granulated sugar	3 lbs.
Water	3 pints
Tartaric acid	2 grams
Benzoate of soda	2.8 grams
Sodium arsenate (C.P.)	5 grams
Strained honey	1.5 lbs.

This poison may be placed in a container with a closed top with holes punched in the lid. Addition of methylene blue dye will denature the solution to prevent accidental human use. If the ant colony is located it can be destroyed by kerosene, gasoline, or carbon disulphide.

Rodents and other animals*

The rodent problem in food establishments is mainly one of controlling and eliminating the rat (*Rattus norvegicus*, the brown rat, is the principal species involved). Mice infest food places, but generally they can be destroyed by trapping, although rat-proofing methods apply also to the elimination of mice. The rat is a greater menace to the health of mankind and a greater destroyer of property than any other animal in the world.[38] Rats may contaminate food mechanically by transferring pathogens from waste materials; they may be carriers of intestinal parasites, particularly tapeworms; they are frequently infested with *Trichinella spiralis;* they may carry the

* Successful control of rats is of sufficient significance to require special study, training, and experience. Only a brief discussion of control applicable to food establishments is possible in this text.

causative agent of infectious jaundice and by contaminating food with their excreta transmit that disease to man. Examination of rat and mouse excreta collected throughout the United States revealed that 1.2 per cent of the animals examined were excreting food-poisoning organisms of the *Salmonella* type.[48]

Eradication measures will not be successful until openings through which rats gain access to buildings have been permanently blocked, harborages eliminated, garbage properly disposed of, and food made inaccessible. These four factors, at least, require constant emphasis if rat infestation is to be eliminated. New structures should, of course, be so built that they are rat proof, but even older buildings can be greatly improved if defects are treated systematically. Such preventive measures as the installation of metal collars around pipes, metal flashings on doors, door checks so that doors will close tight, metal screening over basement windows, placing anti-gnawing material over openings and holes leading to enclosed spaces and double walls, repairing defects in foundations, and removing rubbish from around the premises are of material aid. Baiting and trapping will avail little if rats can eat garbage carelessly spilled in the yard and find easy passageway in and out of the building. Rodent control in its several phases is an activity of considerable significance and if the rat population of a community is to be markedly reduced a well-planned continuing program must be carried on.

After blocking and building the rat out have been accomplished, poisoning, trapping, or fumigation may be employed. Poisoning is an effective and preferred method. Red squill (one part squill to eight or nine parts bait) and barium carbonate (one part carbonate to four or five parts bait) are two poisons that will kill rats yet are safe to use and will not, in the dosage used, endanger other animals or humans. These formulas for the preparation of red squill bait are suggested:

1.	Ground condemned meat	5 lbs.
	Bread crumbs	4 lbs.
	Red squill*	1 lb.
2.	Bread crumbs	8 lbs.
	Waste cooking fat	1 lb.
	Red squill*	1 lb.

* Fortified red squill should be used having a standardized minimum lethal toxicity of 600 milligrams per kilogram of body weight for male rats.

Arsenic, phosphorous, strychnine, zinc phosphide, and thallium sulphate may be mentioned, but all are dangerous poisons and extreme precautions must be taken when they are used. Pre-baiting with a variety of foods is advisable since rats like variety, yet are very wary. After several days the unconsumed baits should be collected, all foodstuffs which might be available to the rats should be covered, and then the poisoned baits may be placed about. A repetition of this procedure should be carried out at intervals, since one application will seldom destroy all the rats.

Very recent and encouraging developments in rodent control involve the use of two new poisons which give unprecedented promise. The first, referred to under its laboratory serial number as "1080," is chemically designated as *sodium fluoroacetate*. The second is the compound *alpha-naphthyl-thiourea* (ANTU), which was developed as a rodenticide as a result of research by Dr. Curt P. Richter of Johns Hopkins University.[40]

While "1080" is a very effective rodenticide, it is also a toxic poison and must be used with great care. It is extremely toxic to a variety of small mammals and is hazardous to humans, domestic livestock, and beneficial wildlife that accidentally come in contact with it. The United States Public Health Service, through its Office of Malaria Control in War Areas, Atlanta, Georgia, has issued the following recommendations, precautions, and instructions in connection with "1080":*

> Previous experience with 1080 has been limited to poisoning water, which is the safest method for employing such a toxic poison. The poison should be carefully weighed and the amount of water accurately measured to insure the proper concentration. The poisoned water should be placed in one-ounce or smaller containers. One-half or ¾-ounce squat soufflé cups are very satisfactory and may be purchased for approximately $1.50 per 1,000 from various paper cup companies. Small, heavy glass caster cups are also suitable. Containers and poison should be recovered after the poisoning period is completed as otherwise the poison will remain and continue to be dangerous. The collected poison should not be reused. Search for dead rats should be made daily throughout the period that the poison is used. Dead rats should be disposed of in such a manner that dogs or cats cannot eat them. They should not be placed in garbage which may be fed to pigs or other animals. Sick rats should be

* Typhus Control Memorandum No. 12, revised February 25, 1946. Information Concerning Poison 1080, Rodenticide.

captured in cages and observed for a week for reporting on the action of 1080. For experimental purposes, 1080 should be the only poison used during the test, and no other poison should be used for the week preceding or following the use of 1080. All poisoned water should be disposed of by flushing down the sanitary sewer with large amounts of water. All used paper cups and dead rodents or other animals should be disposed of by incineration or by burial more than three feet deep. All equipment coming in contact with 1080 should be thoroughly rinsed as soon as possible after use and before being stored away. Wash hands thoroughly after contact with 1080 in any form before eating or smoking.

Every container of 1080 water should be placed in a location so protected that no animals except rats and mice can have access to it. If natural protection is not available, an expanded metal, sheet metal, or wooden protecting piece should be securely anchored so that it is not more than three inches above the surface on which the poison container is placed and extends at least six inches laterally on all open sides. A 12″ x 12″ piece securely anchored not more than 3″ from the floor will protect the bait from other animals but not chickens. *1080 should not be used out-of-doors, in residences, or in or near places where pigs or chickens are kept.*

Previous experiments by the USPHS have been made with poisoned water prepared by dissolving ½ oz. (14 grams) of 1080 per gallon of water. Experiments by the U. S. Fish and Wildlife Service have utilized as low as 8–12 grams per gallon with good results against both species of rats. Because of the danger of killing pets which eat dead rodents, the concentration should be as near the minimum lethal dose for rats as possible. It is therefore recommended that 12 grams of 1080 per gallon of water be utilized in preparing poisoned water until further information is available.

Precautions—Poisoned water containers and all equipment coming into contact with 1080 in any form should be labelled "POISON." The 1080 powder should be weighed out in the laboratory or drug store on accurate metric scales. It is suggested that 6 gram lots be placed in individual glass containers with screw tops, such as one-ounce ointment jars. These jars can then be carried into the establishment and the contents of one jar dissolved in one-half gallon of water. Stir the water to insure complete solution of 1080. Buckets and spoons should all be labelled "POISON." To avoid spilling water in filling the small cups, it is recommended that rubber bulbs, similar to syringes or hand dusting bulbs, be used to squirt the water accurately into the cups. The empty cups should be previously placed in the final locations. Cups should not be placed upon boxes, ledges, pipes, or other unstable mounts—but only on the floor. Place cups about four to six inches from rat runs rather than directly on the runs where they are likely to be tipped over by rats. Do not

place cups where movement of workers or customers in the establishment will disturb them. Do not place cups in any establishment to which children have access during the poisoning period. Do not place cups on any merchandise or on spilled grain, sugar, or other food product. Cups should not be filled more than two-thirds full. If one-ounce cups are used, they should be only half filled. The exact number of cups placed in each room should be recorded, and every cup should be recovered following the experimental period, avoiding spilling during the process.

Further precautions in distributing poisoned water may be taken by adding about 20 drops of black India ink to one-half gallon of water. This gives the water a dirty gray color. Cups should be labelled or stamped "POISON" in waterproof ink or paint. The chemical should be kept under lock when not in use and the poisoning kit should be provided with a lock.

Compound 1080 is so toxic that great care must be utilized in handling it. If the hands are to come in contact with 1080, rubber gloves should be worn. If there is danger of respiratory exposure to 1080 dust, a respirator should be worn. The chief danger is from ingesting the poison. There is little danger of absorbing 1080 through the unbroken skin.

Poison 1080 acts chiefly upon the heart, with a secondary effect on the central nervous system. Death usually results from heart failure following ventricular fibrillation. Convulsions may result from the action on the nervous system.

ANTU is much safer to use than 1080 but also less effective. It does, however, have two unusual features: first, it acts almost exclusively on rats, leaving humans and most other species unharmed (deaths of dogs from the poison have been reported, however); and second, it kills rats in an unusual way by its action on the capillaries of the lungs, producing a drowning pulmonary edema if death occurs within 24 hours. The United States Public Health Service reports that experience on typhus control programs has indicated that excellent to poor kills of Norway rats are obtained by using 20 per cent in a dust mixture with flour or pyrophyllite.*

Where ANTU is to be applied as a dust in rat runs, entrances, and harborages, a 20 per cent mixture should be used. A mixture of 20 per cent ANTU and 80 per cent premixed pyrophyllite dust containing 10 per cent DDT will give a final concentration of 20 per cent ANTU and 8 per cent DDT.

* Typhus Control Memorandum No. 15, December 17, 1945. Information Concerning Poison ANTU, Rodenticide.

Commenting further on ANTU, the United States Public Health Service reports:

> Observers have determined that ANTU is readily acceptable in poison baits and may be used against Norway rats in this manner. The poison should be used in 3 per cent strength by weight or may be sprinkled lightly on fresh fruit or vegetable squares. Mixed baits may be placed in teaspoonful quantities or wrapped in torpedoes. The same care should be exercised with ANTU poisoned baits as with arsenic trioxide, thallium sulphate, or zinc phosphide baits. Although ANTU has been reported as fairly successful when used in poisoning water, its relative insolubility in water is a decided disadvantage. Other poisons such as 1080, thallium, or arsenic are recommended for use in poisoning water.
>
> Because ANTU tolerance in rats is quickly established and this lasts for at least a month, reuse of this poison within 30 days is not advocated. Generally, it is best not to apply ANTU more than once during any six-month period. Therefore ANTU when used in any form should be thoroughly applied.
>
> ANTU dust or a DDT-ANTU dust mixture must be applied with greater care than DDT residual dust, particularly around food or foodstuffs because of danger of contamination by this poison. Although ANTU is reported to have some emetic effect on dogs, a number have been killed by ANTU poisoned baits and it is recommended that ANTU not be mixed with meat or other baits normally attractive to dogs. After application of ANTU dust or baits, the premises should be visited daily for at least a week. All dead rodents should be recovered and safely disposed of by incineration or deep burial.
>
> Results tend to indicate that best kills are obtained using ANTU dust mixtures where there is considerable water on the floors. Better kills may possibly be obtained, particularly in dry basements, by wetting the floor around the ANTU dust patches.
>
> Rats surviving initial doses of ANTU were found by USPHS investigators to develop a marked tolerance to the poison to such an extent that 100 mg./kg. doses at 3-day intervals killed none of 14 rats in one series and 42 per cent of 19 rats in another (albino rats, Wister strain).
>
> ANTU can be handled readily without danger by project personnel, provided moderate precautions are taken to avoid excessive inhalation. It does not affect and is not absorbed by the skin. Its action as a dust in killing rats is apparently due to ingestion during cleaning and preening.

Trapping may also be employed, although it requires more labor and skill than poisoning. The wood-base snap or guillotine trap is the most satisfactory type for routine use. Baits should be varied to include such foods as fish, fried bacon, liver, fresh bread, cheese, dough-

nuts, or fruits and vegetables such as cantaloupe, bananas, tomatoes, and sweet potatoes. Traps should be placed along runways and in passages used by rats. Successful trapping requires the use of a large number of traps in order to destroy as many rats as possible before they learn to avoid the traps. Traps should be dipped in scalding water after each catch; immersing them in hot melted paraffin will aid in deodorizing them.

Fumigation with hydrocyanic acid gas is, of course, a most effective method and will kill all rats within the exposed area when the gas is properly generated and the work done by qualified persons. One disadvantage is that rats may die in inaccessible places, decompose, and cause a disagreeable odor.

Other animals, such as cats and dogs, allowed in rooms where food or drink is prepared or stored subject such products to contamination. Unrestrained cats will walk over food or lie on surfaces where food may be placed, and thus mechanically introduce contamination. Dogs, though not as commonly encountered in food establishments, must be excluded mainly for aesthetic reasons but also because they, too, may mechanically subject food or food containers to contamination. Elevating food at least eighteen inches reasonably protects food from dog contamination.

Dangerous chemicals

The possibility of food contamination by dangerous chemicals must be taken into account. Roach powder containing sodium fluoride when accidentally introduced into food and drink has been the cause of a number of deaths on several occasions. In practically all instances the powder was mistaken for such products as corn starch, flour, milk powder, baking powder, and bicarbonate of soda. Restrictions should be placed upon the sale and use of fluorides except of the tinted variety (nile blue colored, for example). As another precaution, such insecticidal powders must be stored away from kitchens and food storage rooms, and employees warned of the dangerous nature of this chemical.

Another poisonous chemical sometimes encountered is potassium cyanide or sodium cyanide, a constituent of silver polish. (See Appendix page 258 for testing for cyanide in polishes.) For cleaning

silver the cyanide is mixed with hot water and the silver dipped into it. Even washing and rinsing after treatment will not remove the poison; in fact, towels used to wipe cyanide-treated silver have shown traces of the poison. Any silver-polishing operation employing the dipping method should be carefully investigated to determine whether a cyanide preparation is being used. It is further recommended that food ordinances contain a section somewhat as follows:

> It shall be unlawful for any person, firm or corporation operating, maintaining, or conducting any hotel, club, restaurant, coffee shop, lunchroom or other eating place wherein food is served to the public, to use any compound or substance containing any sodium cyanide, potassium cyanide, oxalic acid, mercuric compound, or other poisonous substances, for the cleaning of nickel, copper, silverware or silver plated ware and/or other articles or utensils used for the service or preparation of food or foodstuffs.*

Other chemical substances which may endanger food include zinc, arsenic, antimony, and cadmium. Food must not be placed in zinc-coated ware; in fact, galvanized iron utensils should under no circumstances be used in the preparation of food. Any distinctly acid food will dissolve zinc when in contact with it.

Arsenic in the form of lead arsenate is involved as a spray residue left on fruit. The Federal Food and Drug Administration has, however, set tolerances for spray residue: lead 6.7 p.p.m., and arsenic 3.4 p.p.m. Fruit showing higher amounts must be rewashed before shipment to market.[21] (See Appendix page 260 for testing method.)

Antimony is a chemical mainly involved in food preparation through the use of cheap pans and containers of the gray enamelware variety. Acid foods coming in contact with such ware will dissolve sufficient amounts of this chemical to cause nausea and vomiting within one to two hours. Potato salad to which mayonnaise containing vinegar has been added and gelatin desserts containing fruit acids will dissolve antimony from cheap ware. Enamelware generally is much less suited to restaurant use than stainless steel or aluminum.

Cadmium is another metal used for plating utensils and containers, although warnings of the danger of cadmium-lined containers have been issued by the government. Again, acid food in contact with such metal will dissolve it and cause illness. In the investigation of alleged

* Adapted from ordinance of the city of Chicago.

food-borne outbreaks the possibilities of chemical poisoning attributable to those enumerated should not be overlooked. (See Appendix page 258 for testing method.)

MISCELLANEOUS SOURCES OF CONTAMINATION

Although an attempt has been made to enumerate the major and most significant sources of contamination, there are others which should be mentioned. One frequently encountered is that from dust when floors are swept with an ordinary broom. A soft-bristle push-broom should be used and a sweeping compound employed. Another source relates to the practice of storing bottles of milk, chocolate milk, and bottled fruit juices in refrigerated beverage coolers and permitting the bottle to be submerged so that the cooling water covers the pouring lip of the bottle. Dry refrigerated storage may be the solution to this problem. The contamination of surfaces upon which food is placed, as, for example, a sandwich board or table, is another situation meriting attention. Placing soiled dishes upon such surfaces or wiping with a soiled towel will contaminate the food being prepared. The use of unclean cutlery may be another source of contamination (a type of cutlery sheath that can be opened for cleaning is shown in Figure 40). Vegetables which are eaten raw, such as celery, carrots, and lettuce, must be thoroughly washed so that contamination-containing bacteria will be removed.

The sanitarian must be aware of all these potential hazards to food, and any condition conducive to the introduction of contamination to

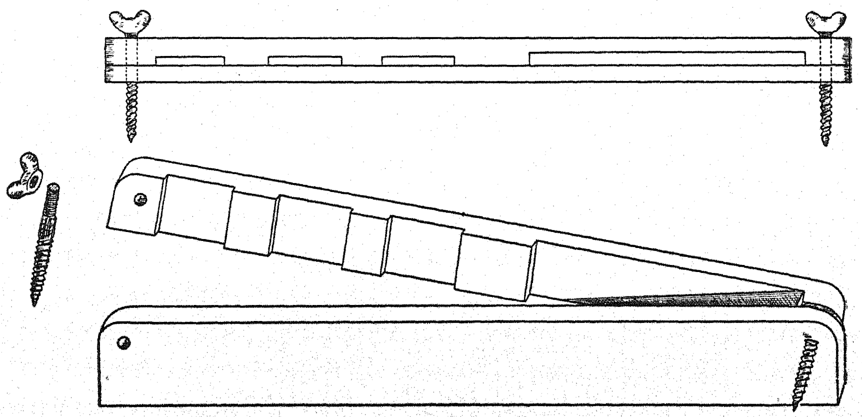


Figure 40. Cutlery sheath that can be opened for cleaning

food must be pointed out to the food establishment operator and satisfactory recommendations made to effect a remedy.

WASHING, SANITIZING, AND STORING UTENSILS AND EQUIPMENT

While epidemiological data and absolute proof of cases or outbreaks of disease caused by unsanitized utensils are meager in contrast to cases attributable directly to food, water, milk, and milk products, sufficient bacteriological data have been accumulated on the transmission of disease from person to person when unclean multi-use containers and utensils are used. Even though it may be difficult to evaluate the extent to which unclean glasses and silverware do transmit disease, it is a certainty that those properly sanitized do not. It is the considered judgment of sanitarians generally that saliva-borne and respiratory diseases in particular can be transmitted by such inanimate objects as unclean eating utensils and glasses. In 1917, at Camp Tanforan, California, Cumming[12] found in an epidemiological study of 66,076 troops that the influenza rate was only 51 per 1,000 among those who had the advantage of collective washing of utensils, whereas it was 252 per 1,000 among those who washed their own mess kits in warm water. Dick and Hucker[14] have shown that of 100 individuals tested, the organism *Streptococcus salivarius* was recovered from the closed lips of the entire test group, and that without exception in these 100 controlled cases streptococci from the lips were deposited on the rims of all glasses used. While these investigators point out that *Streptococcus salivarius* is not a pathogen, it is an organism which may be used as an index of oral contamination of drinking glasses. Krog,[30] in a survey of eating and drinking places in Plainfield, New Jersey, found that bacteria recovered from eating utensils and glasses in many instances ran as high as 75,000 to 100,000 per utensil or glass, and that the bacteria count on rinse water ran into the hundreds of thousands, and even into the millions, per milliliter of sample examined. Other investigators have substantiated these findings to add further proof that utensils and glasses served in many public places are far from acceptable, from the standpoint of both bacteriological and esthetic standards. All of this information confirms the fact that many of the routine methods and systems now employed to render dishes, utensils, and glasses acceptable from the

sanitary viewpoint are far from ideal, that a tremendous amount of work remains to be done, and that definite practical improvement is acutely needed in this one phase of the food business alone.

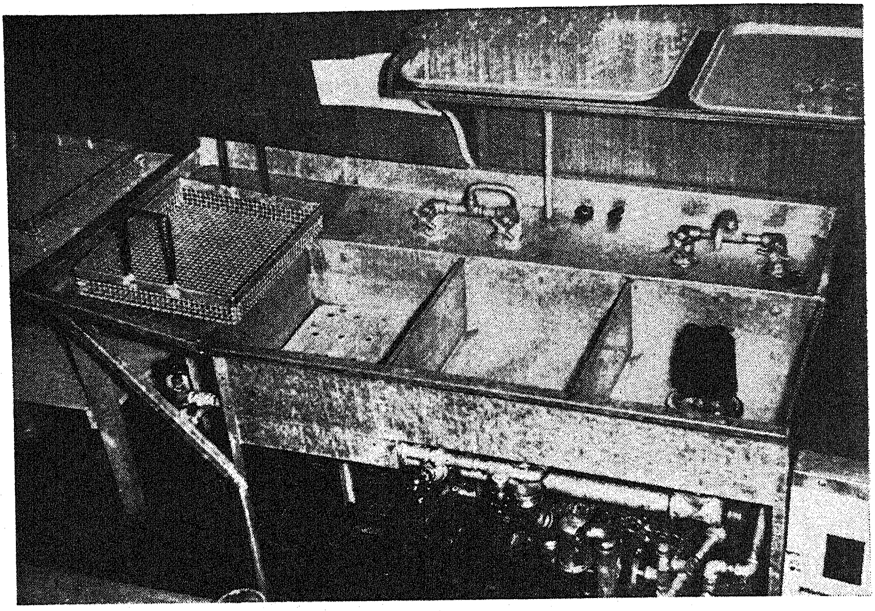
Dishwashing, in its broadest sense, is a problem both of equipment and of methods. It involves the type of equipment used and its maintenance, the kind of washing compound employed, the adequacy of the hot water supply, the use of heat or chemical agents for sanitizing, the proper racking, storage, and handling of both soiled and clean dishes, and the methods employed by the persons doing the work. Each phase in this enumeration has its contribution to make, and each constitutes a problem in itself.

The type of equipment used will depend upon whether the dishwashing operation is done by hand or by machine, or by a combination of the two.

Hand dishwashing

Hand dishwashing under practical conditions is commonly divided into two separate operations: first, the washing of dishes such as plates, side dishes, cups, bowls, silverware, and food containers; and second, the washing of glasses. Even among establishments of a poorer grade this division is regularly found, though the same facilities may be used for both types of utensils. The kind of equipment used to wash the dishes is not as important as the efficiency of the washing operation, although practical experience dictates the use of stationary vats or sinks supplied with running hot and cold water and proper traps and sewer connections. When chemical bactericidal treatment is used, a three-compartment sink is the type most suitable (see Figures 41 and 42).

Hand dishwashing methods employed in many public eating places are primarily home methods applied on a larger scale. Dishwashing methods in the average home have changed relatively little over the years, and the influence of the household has been carried over to the restaurant. This, coupled with the fact that dishwashing is considered a menial task requiring little or no experience, acts as a definite deterrent to improvement. Sanitarians know that the application of average intelligence to the operation, plus the use of a few simple devices and methods, will result in acceptable cleanliness. The problem, then, is to replace outmoded dishwashing customs, instruct



Courtesy Fargo, N.D., Health Dept.

Figure 41. A three-compartment sink is needed when a chemical bactericide is used

DISHWASHING AND SANITIZING USING THE THREE-COMPARTMENT SINK METHOD

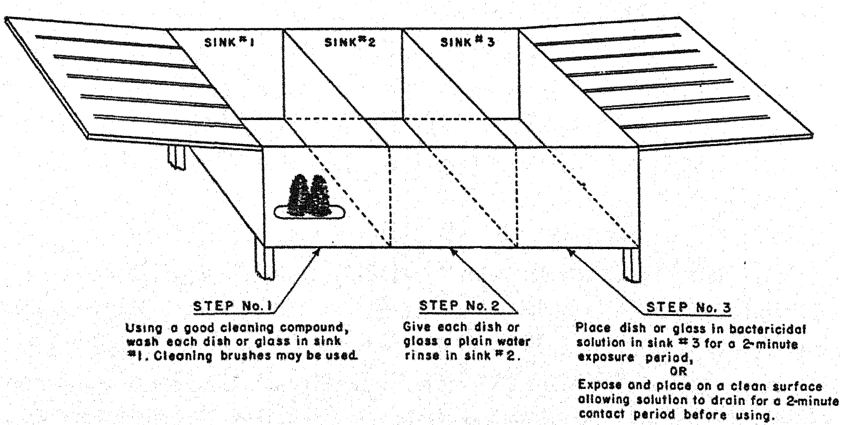


Figure 42. This type of sketch may be used to show food and drink establishment operators proper washing and sanitizing procedures

operators in more effective methods, and require that these methods be used.

Among the first requirements for effective dishwashing, either hand or machine, is the scraping of soiled dishes to remove as much remaining food as possible. An additional step, pre-rinsing, may be employed; in fact, it is to be encouraged. The temperature of the wash water is the next consideration: it should be as hot as can be borne by the hands, generally a temperature of 115° to 120° F. Water at this temperature facilitates the washing operation and assists in keeping the bacterial content at a minimum. The effect of temperature on the bacteria count of dishwashing solutions was studied by Stone,[6] who showed that in 73 establishments maintaining a water temperature of 110° F. or under, the average bacteria count per milliliter was 154,630; whereas in 26 establishments maintaining a temperature of 111° F. or over, the average count per milliliter was 3,900. These findings emphasize the point that operators must be taught the importance of water temperature and made to realize that good results cannot be obtained with tepid water or with water grossly contaminated. Obviously, the water should be changed at frequent intervals, otherwise the soap or washing compound used will become ineffective. The washing operation is particularly important since effective bactericidal treatment cannot be accomplished unless dishes and utensils are physically clean. At least as much emphasis should be placed upon the methods employed and the results obtained in washing as upon the sanitizing treatment.

As in any washing and cleansing operation, the washing compound employed has a decided effect upon final results. A good detergent should have the following qualities:

1. Wetting: the ability to wet readily the utensil being cleaned.
2. Emulsification: the ability to emulsify the fats from the food soil on the utensils.
3. Dissolving: the ability to dissolve food materials, principally proteins.
4. Deflocculation: the ability to break up dirt particles.
5. Dispersion: the detergent should function properly in hard or soft water, and preferably should be of a type which will minimize the formation of a film or deposit of mineral salts and similar substances on the utensils and equipment. This property of film-prevention is called dispersion because the products of the chemical reaction be-

tween the detergent and the hardness-constituents of the water are kept dispersed in the solution and their precipitation, with consequent formation of film, is minimized.

6. Rinsing: the property of being easily rinsed off the utensil by clean water.[4]

While the formulas used by the many manufacturers of detergents are generally not stated on the container, the general properties of several detergent ingredients are as follows:

1. Sodium hydroxide (lye) is a good dissolving agent but lacks the other properties, and is extremely dangerous to the skin and eyes. In general, the alkalis are ineffective detergents by themselves.
2. Soap is a good simple detergent when used in soft water, although it has no dispersion property and, obviously, its properties of emulsification and deflocculation are limited. The reaction between soap and the hardness-constituents of water results in insoluble soap, which leaves a deposit on the utensils and equipment.
3. Sodium carbonate (soda ash) has the properties of the alkalis and is useful as a water softener. The products of the reaction precipitate and form films.
4. Trisodium phosphate has satisfactory emulsifying and deflocculating properties, but its wetting and dispersion properties are insufficient to make it a completely effective detergent for dishwashing. However, it is useful as a water softener.
5. Sodium metasilicate has detergent properties which are similar to those of trisodium phosphate, but it is less corrosive to certain metals.
6. Sodium hexametaphosphate is an effective water-softening agent and has excellent dispersion properties. It forms soluble compounds with the calcium and magnesium hardness-constituents of water, dissolves "lime soaps," and thus acts to prevent the formation of film on utensils and of scale and sludge on sinks and in dishwashing machines. Otherwise, this substance has little detergent property.
7. Tetrasodium pyrophosphate and sodium tetraphosphate have detergent properties similar to those of sodium hexametaphosphate.
8. Various "wetting agents" (sulphated alcohols, for example) have been used by the textile industry to improve the penetration of dyes. Recently, these agents, also called "synthetic detergents," which have definite emulsification and deflocculation properties, have been used in dishwashing detergents. The calcium and magnesium salts of sulphated alcohols are soluble; thus objectionable films and precipitates are avoided.

   Although "wetting agents" or "synthetic detergents" have caused great changes in the detergent field, their utility for certain purposes is limited. Their ability to cause foam or suds is great, and if the wash-

ing solution is pumped, as in most dishwashing machines, only a small amount of a wetting agent can be used in the detergent mixture; otherwise a thick blanket of foam will interfere with operation.

9. Other ingredients are often used in detergent compounds. For example, buffering and other substances are used to decrease the violence of the alkaline reaction and to minimize corrosion of metal sinks and dishwashing machines. Inert abrasives are sometimes used but are generally undesirable in dishwashing detergents.

There are many and various cleaning compounds and detergents on the market, and the sanitarian is frequently asked advice concerning them. He should base his judgment upon observation of a given product under actual conditions of use. Chemical composition alone is not always the determining factor, since the composition of the water, the temperature of the water, and the type of soil all have a bearing upon the efficiency of detergent action. The problem of cleaning agents in relation to dishwashing is complex and relatively little is known about the chemical reactions of many of the compounds employed. Wetting agents, or the so-called sulphated alcohols, have been used for many years in the textile industry and are coming into more general use in the food industry. They give particular promise for their emulsifying properties. What is desired, however, is a compound soluble in water at a temperature of 120° F. which will remove all types of soiling material in a short time and give a free rinsing surface, prevent film formation, and work effectively in waters of varying hardness. Wetting agents alone will not do this, but when combined with other chemicals they give very acceptable results. When products used locally closely approximate such requirements, and give good results, there need be no hesitancy in recommending them as satisfactory for hand dishwashing. It should be pointed out, however, that any soap of good quality is a satisfactory cleaner when soft water is used; in fact, a recent investigation indicates that soap in a concentration of one part per thousand strongly inactivated dilute preparations of both type A and type B influenza virus, whereas certain other bactericides and detergents failed to do so.[32]

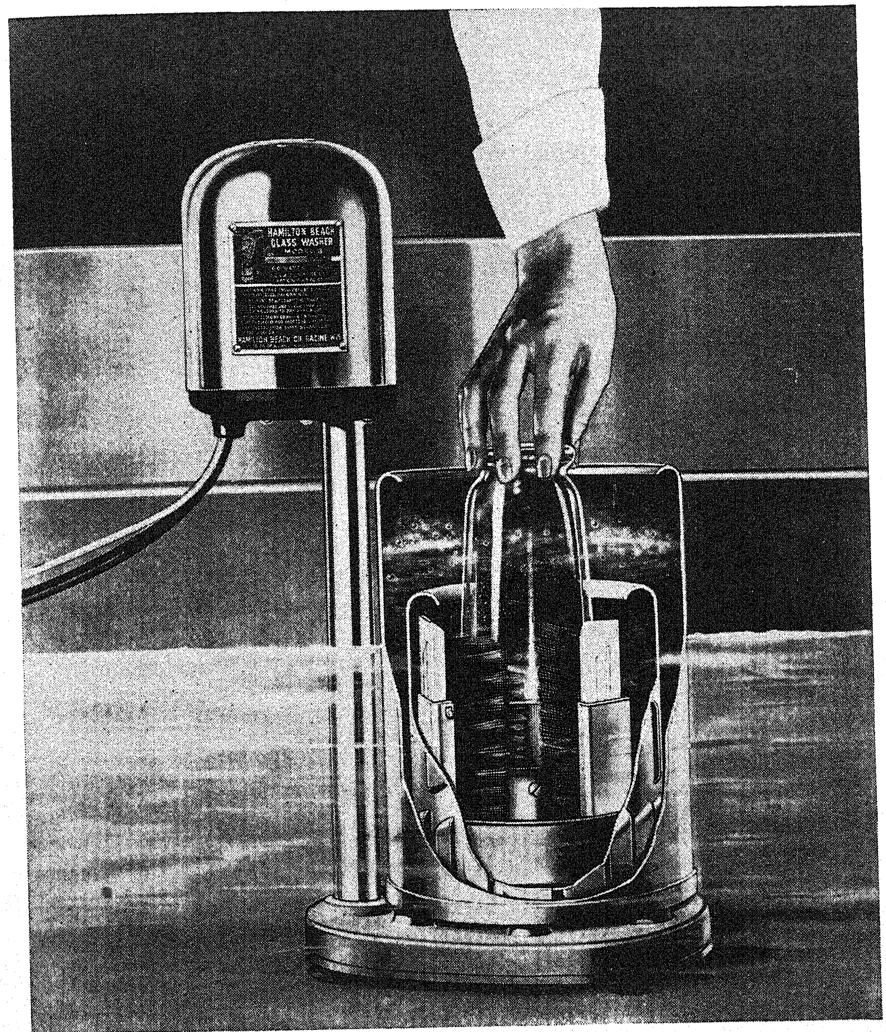
Beverage glasses

The washing and sanitizing of beverage glasses are usually separate parts of the dishwashing operation, and will be so considered here. In practice it is frequently found that many establishments such as

soda fountains, dairy bars, soft-drink places, and those serving alcoholic beverages handle little if any food, and as a consequence one of the major public health interests of the sanitarian here is the equipment and methods used for glass washing and sanitizing.

From an entirely practical point of view, it is not difficult for a careful operator to properly sanitize a glass if certain basic principles are borne in mind. First of all, there must be hot and cold running water, piped to a fountain or bar sink properly connected. Ideally, the sink should be of the three-compartment type, although there are two-compartment installations which give satisfactory results. When a new program is being initiated or a new or amended food ordinance has been passed, the three-compartment sink should be a requirement and all replacements or new installations should be of that type. The use of spray rinsing devices should be discouraged; in fact, they should be prohibited in new installations. The contention is sometimes made that a rinser serves to sanitize the glass after it has been washed, or that it may be employed as a rinse prior to sanitizing. In the first instance, such is not the case, since one is unable to hold the glass for a period sufficiently long to sanitize it at the necessary water temperature of 170° F. or above; and in the second, a rinser is too frequently used as a substitute for washing, it may be used for both a soiled and a clean glass, or, as commonly seen, it may be used as the final rinsing device. As a result, the desired contact with bactericidal action of the sanitizing solution is nullified. For promoting efficiency in glass washing, brushes may be used; in fact, their use should be encouraged. These may be double or triple brushes, either of the stationary variety held in the sink by rubber suction discs or, better still, of the rotary motor-operated type (see Figure 43). The friction or scrubbing action exerted by the bristles against the glass is decidedly effective in removing soil. Operators should be urged to keep several sets of brushes on hand; brushes should be boiled daily and replaced weekly; alternating them will prolong their usefulness. To further facilitate the cleaning operation, it is necessary to use hot water and a good glass-washing compound, preferably one containing a wetting agent.

After the glass has been washed, it is ready for rinsing in the second compartment of the sink. The rinse water should be as hot as the hands can stand. The rinsing operation is for the purpose of removing any



Courtesy Hamilton Beach Co., Racine, Wisc.

Figure 43. Type of motor-driven glass washer

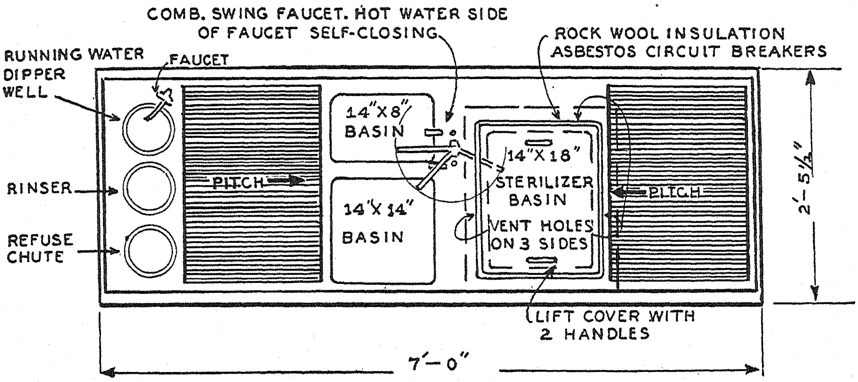
remaining soil, detergent, or organic material, and to facilitate action of the sanitizing agent which follows.

If a hypochlorite solution is used for sanitizing, it should be made up to an initial strength of 100 p.p.m. and its strength should not be permitted to fall below 50 p.p.m. If a chloramine is employed, it must be made up to a sufficiently greater concentration to produce an equivalent bactericidal strength; the use of slower-acting chloramines is inadvisable in restaurants and beverage-dispensing places where time is so important a factor. An exposure period of two minutes is recommended. This may be accomplished either by allowing glasses to remain in the sanitizing solution for that period of time, or by the more practical method of totally submerging them and then placing them in an inverted position on a clean metal drainboard or in glass storage racks to drain for two or more minutes. Although leaving glasses in the sanitizing solution is the more desirable method, it presents the problem of breakage and danger to the operator of cutting his hands, and it has been shown that glasses can be bacteriologically satisfactory when they are allowed to drain for two or more minutes with the sanitizing solution left on them.[6] The chemical sanitizing solution need not be hot; in fact, since a cold glass is usually desired, cold water is generally preferred. If hot-water sanitization is used, metal dipping baskets with long handles are needed to hold the glasses so that they may be submerged in water at 170° F. or above for a two-minute exposure period. An arrangement showing one such installation for hot-water sanitization is shown in Figure 44.

The final operation is the storage of the sanitized glasses. Storage must be on a clean surface, with the glasses always inverted. If glasses are stored on a corrugated drainboard, the board should be periodically flushed with a bactericidal solution, as should trays or wire racks if they are used. Storage on wood or on towels is to be discouraged—the most satisfactory means of storage is in racks or baskets specifically designed to hold glasses. Handling of glasses has been mentioned previously, but it is important to repeat that they must be handled from the bottom with fingers kept away from the rim. The sanitarian will do well to urge operators to have a generous supply of properly sanitized glasses on hand to facilitate operation during busy periods.

In a discussion of beverage glasses the use of single-service paper cups and containers deserves consideration. Many sanitarians feel

that a utensil used once and discarded is a solution to the dishwashing problem, and it unquestionably is if drinking glasses alone are to be considered. But paper service does not eliminate the problem of knife, fork, and spoon, which must be properly sanitized. In addition, all beverage serving does not appear to lend itself readily to single-service devices. As a consequence, other methods must be devised to provide clean and safe glasses and containers so far as that is possible.



Adapted from drawing supplied by Liquid Carbonic Co., Chicago

Figure 44. Plan view of glass-washing and sanitizing arrangement suitable for use at a fountain or lunch counter. Note sanitizing vat on right which permits immersion of baskets of glasses in water at 170° F. or above

It is within the realm of reasonableness, however, to require single-service glasses when sanitized glasses are not otherwise available. Single-service paper containers are a definite solution to the problem of the insanitary drinking glass, and requiring their use is reasonable. Obviously the same careful handling practices must be employed for paper service as for sanitized glasses.

Mechanical dishwashing

The mechanical dishwashing machine is now a common piece of equipment in the larger and better-grade restaurants. However, many of these machines are not designed to give adequate bactericidal treatment to dishes, glasses, and silverware; in practically all machines of an older design, at least, manufacturers have emphasized washing operation rather than effective bactericidal treatment. Basi-

cally the compartment for the hot water bactericidal treatment should be sufficiently large to insure that the surface of every dish or utensil will be subjected to a thorough spraying for an adequate period of time, with water at 170° F. or above, to bring about sanitizing action. As is now the case with most single-tank installations, the only sanitizing rinse obtained is a cursory one depending upon the operator and whether he pushes the rack of dishes slowly or rapidly past the hot water spray jets. This situation has been appreciated for several years by public health engineers who have studied the operation of various makes of machines under routine working conditions. The American Public Health Association now has a Committee on Disinfection of Dishes and Utensils[3] whose assignment is to study dishwashing methods and machines with a view to correcting defects. As a result of their deliberations and recommendations, it is to be anticipated that later models will incorporate much-needed improvements.

While the mechanical dishwasher partly eliminates the human factor in the dishwashing operation, its use does not imply that machine-washed dishes are more sanitary than dishes washed properly by hand. There are several important operating procedures which must be considered if acceptable mechanically washed dishes are to result, and investigators who have studied the problem are in general agreement concerning them.

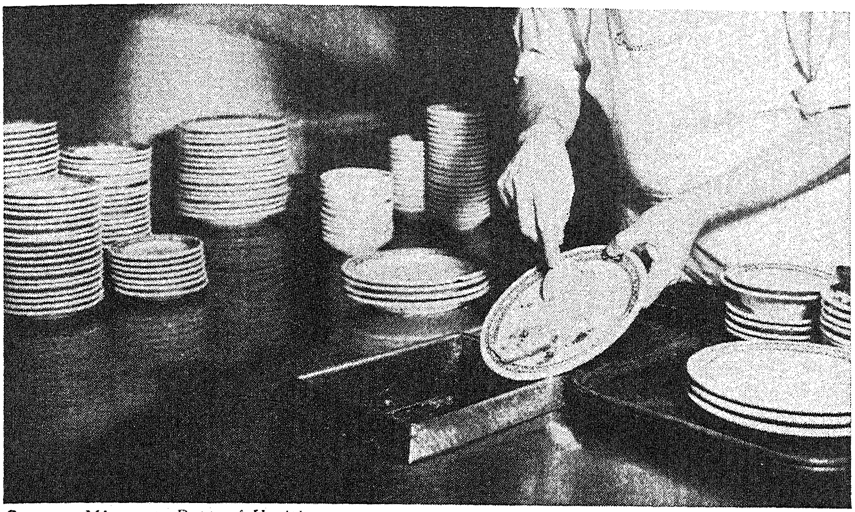
1. As was pointed out in the discussion of hand dishwashing, the dishes must be well scraped. It is obvious that it is easier to remove soil manually than by means of the washing action. (See Figure 45.)

2. The dishes should be pre-rinsed. This will remove still more soil and will help conserve the cleansing ability of the detergent. (Figure 46 shows one type of pre-rinsing device.)

3. The dishes should be washed as soon after use as possible to prevent drying of food particles.

4. The wash water temperature should be maintained at about 140° F.* (Unanimity of opinion on this point is lacking, and further investigation is needed.) A good detergent in sufficient concentration should be used. The directions of the manufacturer should be followed to give the requisite concentration. Detergent dispensers may be used as a means of maintaining strength of the washing solution. Selection of a good detergent is predicated upon the results obtained. At present a list of

* The United States Army recommends 140° F. and a wash period of at least 40 seconds; the Navy recommends 120° F., not to exceed 140° F., and a wash period of at least 30 seconds.



Courtesy Minnesota Dept. of Health

Figure 45. Careful scraping of dishes prior to washing means less contamination of the dish water and longer usefulness of the detergent

tested and approved detergents is not available. The problem is a complex one and there are many variables.

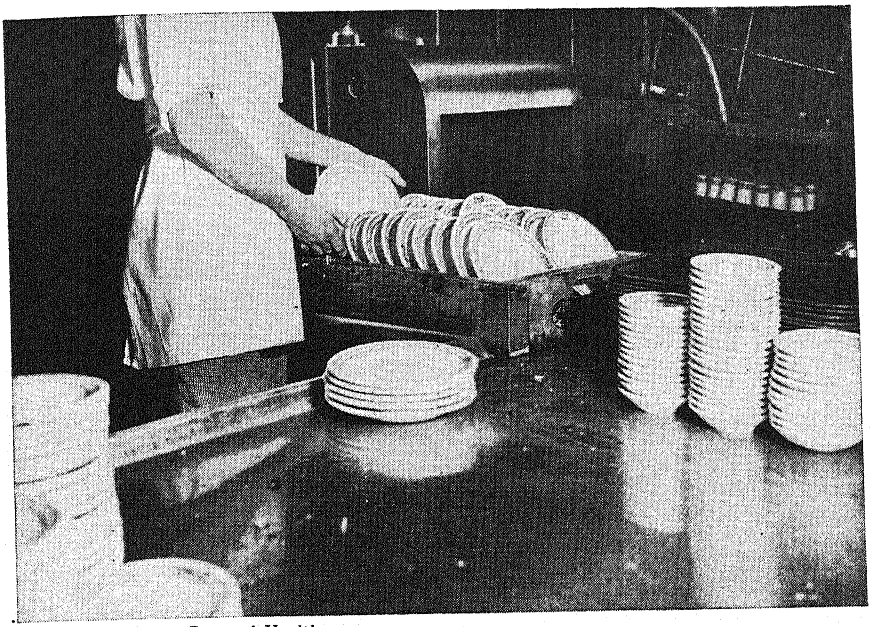
5. Dishes must be so spaced in dish racks that all surfaces are exposed to the full force of the wash and rinse. Crowding one dish upon another or nesting them too closely prevents effective cleansing. (See Figure 47.)

6. The dishes must be subjected to bactericidal action. Hot water is generally the medium employed to accomplish this in mechanical washers. Ideally, the surface of each dish or utensil should be subjected to a hot water spray of substantial volume, the water to be not less than 170° F. and the exposure period not less than 20 to 40 seconds (again, there are differences of opinion on this point). In actual practice, however, a rinse period of only a few seconds is common. Further study may indicate what constitutes proper exposure, when hot water of varying degrees of temperature is used.

7. The sanitized dishes must be stored in a clean, protected place with handling reduced to a minimum. Toweling is not recommended, although it is the usual practice in the majority of restaurants. Contamination may be transferred from one dish to others via the towel, thus defeating the purpose of the sanitizing process. If towels are used—and this practice certainly should be discouraged—only clean ones should be used. A strong argument against toweling is that dishes sanitized at 170° F. or above rapidly drain and dry of themselves.[33]

Courtesy Salvajor Co., Kansas City, Mo.

Figure 46. This device pre-rinses dishes and salvages silver and small dishes which may accidentally be scraped away with waste food

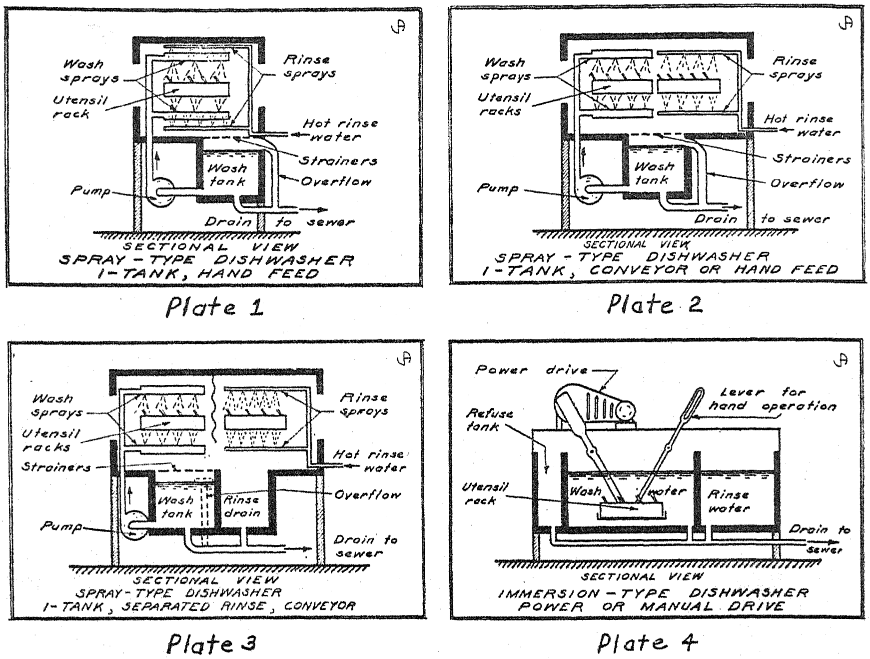


Courtesy Minnesota Dept. of Health

Figure 47. Proper racking of dishes is necessary so that wash and rinse water will contact all surfaces

There are several types and many makes of mechanical dishwashers on the market (see sectional views, Figure 48). Nearly all manufacturers have descriptive literature available which may be consulted and studied for structural details. In general, the principles of operation of dishwashing machines now on the market are basically the same, and the following discussion is mainly for the purpose of describing briefly three different types commonly encountered.

The first type (see Figure 48, Plates 1, 2, and 3) requires that the operator load dishes, glasses, or silverware into a rack which is built to correct size for pushing through the machine. The loading racks have wood dowel separators so that plates and flat ware can be stacked in a vertical position for washing. Racks to hold silverware have supporting dowels near the bottom but generally the bottom is covered with hardware cloth. When the machine is operating, washing is accomplished by pumping streams of water from the wash water tank through stationary or rotating washer arms, the dishes or utensils being subjected to a flushing action of hot water and detergent. When the next rack is loaded and ready, the operator pushes it into the ma-

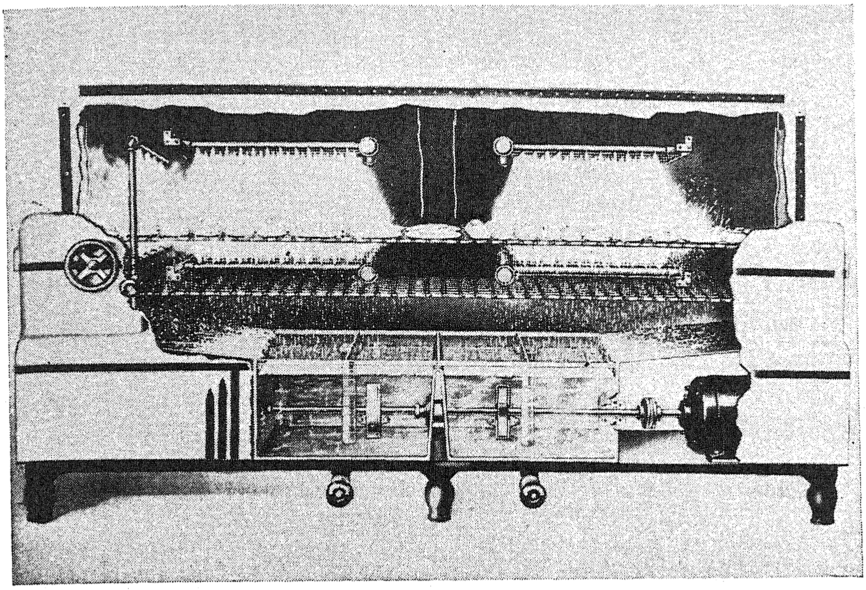


Courtesy United States Public Health Service

Figure 48. Sectional views of several types of dishwashing machines

chine, at the same time pushing the first rack through and out of it. As a rack is pushed through, a valve at the outlet end of the machine is depressed; this releases a hot water spray, usually from a horizontal pipe above and below, or the spraying device may be operated manually from the outside. Rinse or spray pipes are usually fitted with small jets or orifices which when in proper working order and open to free flow distribute the spray over the surfaces of dishes or utensils as they go through. There are variations in the several makes of machines: some, for example, are provided with a conveyor chain which carries the rack slowly through the machine; in others, the racks rock slowly back and forth during the washing operation. There are single- and double-tank machines, but fundamentally the mode of operation is about as described.

The second type is the belt drive or conveyor machine (see Figure 49). In this, dishes are placed face down on an open flexible metal belt which moves and revolves at a slow, steady speed. When the machine is in operation, wash water is forced by means of a centrifu-



Courtesy Champion Dish Washing Machine Co., Erie, Pa.

Figure 49. Conveyor type double-tank machine. Where steam is available, a mixing valve may be installed in the hot water rinse line to insure a water temperature of 170° F. or above

gal pump through jets which spray wash water over all surfaces of the dishes as they pass through. Toward the outlet of the machine are jets which spray hot water over the dishes. This type of machine probably eliminates the human equation to a greater degree than the machine first described, since dishes are not racked and therefore go through at a uniformly slow speed. Again, however, unless all the wash and rinse jets are open, the surface of every dish is not thoroughly washed or subjected to bactericidal action of the hot water spray; and even with the machine in first-class working order, the period of exposure to the sanitizing rinse may be considerably less than that needed to effect acceptable sanitizing action.

The third type of machine, while in the category of a mechanical washer, might be described as a semi-mechanical machine in that more manual operation is involved. With this type (see Figure 48, Plate 4) soiled dishes are placed in a long-handled basket which is then set in a rocker in the washing compartment. The rocker is attached to a shaft or lever which is operated either by hand or by an electric motor. As the lever moves back and forth the rocker moves likewise, thus carry-

ing the basket of dishes back and forth in the wash water. This mechanical agitation of the wash water exerts some scrubbing or detergent action on the dishes. At the end of the wash period the operator lifts the basket out and immerses it in the second compartment containing hot water for sanitization. When dishes have been properly scraped, not crowded too closely in the basket, and a satisfactory detergent used, reasonably good results can be accomplished with this kind of equipment. This type of machine has gas burners under the sanitizing compartment, or it may be supplied with an electric immersion unit to maintain water at the correct temperature.

While no attempt has been made to describe the precise operation of each of the several makes of machines on the market, this brief description of three types should serve to guide the sanitarian in the general principles of operation. There is one other machine which appears to hold promise. This is the automatic machine, so called because it is equipped with a timing device. Once the dishes are placed in the machine, the operator cannot change or vary the operations. Furthermore, this machine will not start operating until the wash water has reached proper temperature, and the time of exposure to washing and rinsing will be automatic and not variable. In Memphis, Tennessee,[36] a regulation covering the operation of such a machine requires that a period of not less than one minute shall be permitted for washing and a similar period for rinsing with water at 170° F.

The bactericidal process

The efficiency of the sanitizing or bactericidal process is, of course, dependent upon several factors: first, the extent to which organic soil and adhering food have been removed from dishes; second, the effectiveness of the rinse in removing any adhering soap, detergent, or soil from the dishes; third, the temperature of the water and/or the proper concentration of chemical; fourth, the exposure period; and fifth, the facilities for handling and storage so that re-contamination is not likely.

When a chemical is used in the bactericidal process, certain points must be borne in mind. The operator must use sufficient chemical, generally sodium or calcium hypochlorite, so that the initial solution has a strength of not less than 100 p.p.m. The solution should not be permitted to fall below 50 p.p.m. and should be freshly prepared as

required, not carried over for use on a succeeding day. Hypochlorites, either liquid or in powder form, are available in various strengths, from approximately 3 to 10 per cent for the liquid type and from 3.25 to 70 per cent for the powder. Even though explicit directions for preparing solutions are given on the label, many operators either fail to read them or do not fully understand them when they do, and solutions much too weak or excessively strong will be encountered. The sanitarian should therefore determine the capacity of the sink or vat being used and proceed to tell the operator the quantity of chemical needed to prepare a solution of correct strength. Directions generally state the quantity to be used for a given amount of water. Chlorine solution feeders which can be attached directly to the water line are on the market in certain sections of the country. These solution feeders are generally installed on a lease basis and part of the service includes the sale of the liquid chlorine to the user. When chlorine is used as a bactericidal agent the sanitarian must spend considerable time instructing operators in its correct use and must make sure that proper residuals are being maintained.

In his program of food establishment supervision the sanitarian must carry as part of his equipment a chlorine test set. Either a thiosulphate starch iodide or an orthotolidin test set is satisfactory for this purpose (for composition of orthotolidin see the American Public Health Association's Standard Methods for the Examination of Water and Sewage). Starch iodide test papers are also available from laboratory supply houses but cannot be relied upon if accurate determinations of chlorine residuals are to be made. Their use is mainly for quick checking to see if chlorine is present. Food establishment proprietors sometimes keep test papers on hand, but the sanitarian should point out that they give only an approximation of the chlorine present and that a more accurate means of testing is available.

In discussing chlorine as a compound for sanitizing purposes one should remember that two kinds are commonly used: the first, either sodium or calcium hypochlorite, represents the inorganic type derived from mineral sources; the second, the chloramines and chloramine T, are derived from plant and animal sources and are considered organic. Inorganic compounds, because of their simple and ionic molecular structure, are characterized by rapidity of chemical reaction; the organic compounds, with a complex and non-ionic molecular

structure, are characterized by a slowness of reaction.[43] The sanitarian must therefore take note of the type of chlorine compound used, since the amount needed for an organic chlorine and the time necessary to effect bactericidal action will be greater than for the inorganic types. Experimental work has shown, in one instance, that a strength of 340 p.p.m. of a chloramine T compound was needed to reduce the bacteria in a water sample from 100,000 to 200 per milliliter within a five-minute exposure period, whereas the same reduction was made using only 34 p.p.m. of available chlorine in the form of sodium hypochlorite.[9] Devereux and Mallmann[13] point out, however, that where the exposure time is sufficiently long there is practically no difference in the bactericidal efficiency of the inorganic and organic compounds. They have shown that after a one-hour interval using *E. coli* as the test organism, the number of bacteria per milliliter in the rinse water from dairy equipment treated with both organic and inorganic chlorine compounds was practically the same. Thus when time is not an important factor chloramine T may be used, but in the food-handling business, and particularly in glass washing, where time is at a premium, the use of the slower-acting chloramine T compounds generally does not seem to be indicated.

In addition to the chlorine bactericides, the quaternary ammonium chlorides (cationic disinfectants) are being currently offered the food industry. One of the earliest to appear on the market was a 10 per cent aqueous solution of alkyl-dimethyl-benzyl ammonium chlorides, sold under the trade name of *Roccal.* Scales and Kemp[41] showed that *Staphylococcus aureus* was destroyed with a 0.0075 per cent (75 p.p.m.) concentration within three minutes, but also that *Bacillus subtilis* was resistant to this bactericide in a concentration of 0.4 per cent at a pH of 9.0 for thirty minutes. In this work an inoculum of 12,000,000 *B. subtilis* organisms per milliliter was used and at the end of a thirty-minute exposure period the count had been reduced to only 5,600,000 per milliliter. These investigators have stated that if the pH of the solution could be raised to 10.5, complete killing of the spores might result.

Krog and Marshall,[31] reporting upon the use of alkyl-dimethyl-benzyl ammonium chlorides for sanitizing eating and drinking utensils, have shown that a 1:5,000 solution demonstrates marked bac-

tericidal action upon organisms found on eating and drinking utensils, and that a one-minute exposure is apparently sufficient to reduce bacteria on washed glasses to below 100 colonies per tumbler rim.

Dunn[16] has reported upon the germicidal properties of this compound using three test organisms, *B. subtilis*, *Staphylococcus aureus*, and *E. coli*. He concluded that the compound demonstrated high germicidal efficacy toward the microorganisms examined both in the presence and in the absence of organic matter. However, *B. subtilis* spores were not destroyed as rapidly as vegetative cells, although germination of the spores was prevented. This investigator was of the opinion that this compound showed marked superiority over several market antiseptics under the conditions of the test, namely, with *Staphylococcus aureus* and *E. coli* at 20° C. and 37° C.

Mallmann, Kivela, and Turney[34] experimented with three quaternary ammonium chlorides (Roccal, B.T.C., and Hyamine 1622) in practical field tests in beverage-dispensing establishments in Lansing, Michigan. After several series of examinations involving tests with between 400 and 800 glasses under actual conditions of use, they found that a dilution of 1:6,400 of any one of these three cationic disinfectant solutions gave very satisfactory results. In one test 700 beverage glasses were washed with a suitable detergent and then rinsed in a cationic solution at a concentration of 1:6,400. After an exposure of thirty seconds to the disinfectant, all but three glasses showed counts below 100 bacteria.

Also investigated was the possible effect glass-washing powders might have on the bactericidal action of cationic disinfectant solutions. Glasses were washed with a commercial product known as *Solvay 600* and again with a cleaner containing hexaphosphate. As a result, the conclusion was reached that wetting agents and polyphosphates had no effect on the sanitizing value of cationics when 800 or less glasses were sanitized using both the two- and three-tank systems of washing and sanitizing. From the work of these investigators it would appear, therefore, that quaternary ammonium chlorides are well suited to use in beverage-dispensing establishments and are effective glass sanitizers.

Ultraviolet light has been advocated as a means of sanitizing beverage glasses. Porter,[39] reporting on the use of Sterilamps, states

that the equipment must be so designed that all glasses will be subjected to a field of radiation emanating from the lamps in such manner that all surfaces will be exposed for a predetermined period of time. In the equipment now available the time of exposure required varies from one to several minutes, depending upon the intensity of radiation and the type of reflecting material used in the cabinets enclosing the lamps. The ability of microorganisms to withstand the bactericidal effect of Sterilamp radiations is noted in another report.[22] In one series of tests, typhoid organisms in water were killed in eight seconds with the lamp at a distance of four inches; the time required to kill *B. coli* at the same distance was about twenty-three seconds.

Appling and Tanner[5] investigated the effectiveness of the Sterilamp on drinking glasses in actual use at soda fountains. The multiple glass test recommended by the American Public Health Association was used in the bacteriological examination of the glasses. These investigators reported as a result of their experiments that "dry, clean glasses showed but slight bacteriological improvement as the result of being exposed. It should be noted, however, that these were already of low bacterial content without being exposed." They stated further that a marked bacteriological improvement was noted when wet clean glasses were exposed but that complete sterilization did not result in every case. The final conclusion was that almost sterile surfaces are produced when clean drinking glasses are irradiated with ultraviolet light produced by the Sterilamp. This work points definitely to the fact that glasses must be washed clean before being exposed to ultraviolet rays. With equipment of this type, as with either hot-water or chemical sanitization, emphasis must always be placed upon the washing operation. In addition, ultraviolet light does not have a residual effect, and though bulbs in use a number of months may still burn, ultraviolet light may not be emitted. It is reasonable to assume that many operators, if not properly instructed, will rely too heavily upon the ultraviolet equipment and neglect the very essential washing procedure.

Hot-water heating

Providing equipment of sufficient capacity to supply restaurants with an ample quantity of water at 170° F. or above during periods

of peak demand is a subject of more than passing significance. By far the majority of restaurants have water-heating systems entirely inadequate to insure sufficient hot water at the correct temperature. As a matter of fact, many systems are installed using whatever apparatus is available locally and without a careful estimation of probable needs. Water heating is generally accomplished by using one of three heating mediums—coal, oil, or illuminating gas, or a combination of them. (Electricity is sometimes, but less frequently, used for commercial water heating.) A coal stoker installation is shown in Figure 50. A commonly encountered installation is a small coal heater connected with a thirty- or fifty-gallon uninsulated tank with a long run of uninsulated pipe, or the same tank connected with a coil, or so-called "side arm," gas heater. With this combination, water when first drawn may be of a sufficiently high temperature, but after ordinary use and draw-off, inadequate recovery capacity of the heater or insufficient storage space or both may result in a lowering of the temperature twenty degrees or more. Water is frequently heated by means of a coil in a furnace connected to a small storage tank. The water may go directly to fixtures or it may be passed through another tank which is gas heated. The latter method, of course, aids in raising the temperature, but unless the gas heater is one of large recovery capacity, water at 170° F. or above is generally not attained, at least for sustained periods.

Some of the factors to be considered in estimating hot water requirements for restaurants are as follows:

1. The method of dishwashing used, whether hand or mechanical;
2. The type and make of mechanical dishwasher used;
3. The volume of dishes to be washed and sanitized;
4. The efficiency with which the equipment is operated;
5. The volume of hot water needed for other things such as pot and pan washing, cooking, and general use.

While figures for total hot water volume needed will vary according to the type of food business conducted and the manner of operation, there are accurate estimates of the amount of hot water at 170° F. required for the operation of certain types of mechanical dishwashers. Beck[7] has studied this problem and taken into account several variables involving both the dishwashing equipment and the operating methods. A résumé of his findings follows:

Type of dishwasher	*Gallons of water at 170° F., for washing and sanitizing*
1. Immersion type	Three times the total tank capacity per hour
2. Single-tank, single-basket door type—wash water tank capacity 15 gallons of water	105 gallons per hour (90 racks of dishes per hour, 8-second rinse, rate of flow 5 gallons per minute. 50 per cent added as safety factor)
3. Rack conveyor, single-tank type	180 gallons per hour if machine is run at peak capacity; actual demand under routine operating conditions, 120 gallons per hour

From these figures it is obvious that the hot water demands for dishwashing machines alone are substantial; if a sanitizing rinse of 170° F. is to be provided, water-heating equipment of adequate capacity is needed.

The American Gas Association[2] studied hot water demands of many food pavilions at the New York World's Fair, where water at 180° F. was required for sanitizing. Two examples are given to show the amount of water at 180° F. needed for sanitizing alone:

Example A. Restaurant with seating capacity of 300. Equipment: Automatic two-tank dishwashing machine—capacity 10,000 pieces per hour. Gallons of 180° F. water used per hour: 75.

Example B. Restaurant with seating capacity of 750. Equipment: Automatic two-tank dishwashing machine—capacity 6,000 pieces per hour. Gallons of 180° F. water used per hour: 120.

While these figures cannot be applied indiscriminately to all restaurant hot water requirements, they do represent the results of careful study and point to the fact that this phase of restaurant sanitation deserves careful attention.

Booster hot water heaters (Figure 51), by means of which water is raised very rapidly to a temperature of 170° F. or above, are available and have been shown to give good results. These are particularly well suited to medium and large-volume restaurants and to those in hotels. Generally, they are used to raise the temperature of the water very rapidly (for example, from 120° F. to 170° F. or above) and operate only when water is being drawn. Companies manufacturing

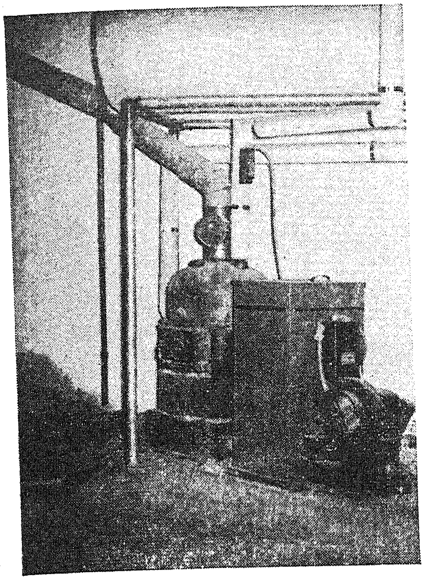


Figure 50. Small coal stoker with insulated storage tank suitable for supplying 170° F. water for the small restaurant

Courtesy Burkay Co., Toledo, Ohio

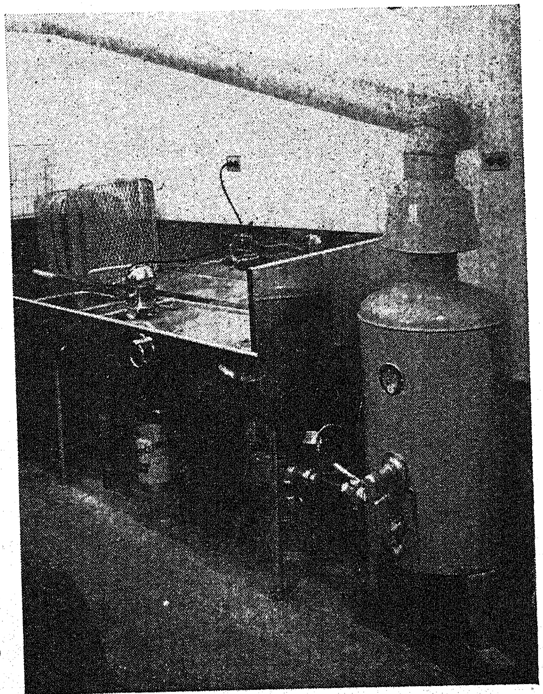


Figure 51. Automatic type booster gas-fired hot-water heater installed adjacent to a glass-washing sink

this type of equipment have literature describing such quick-recovery high-in-put heaters, and study of their literature is recommended. In larger centers the sanitarian should consult the heating engineer of the local utility company, who will be glad to give advice and assistance in commercial water-heating problems. Wherever possible, the sanitarian should urge the installation of hot-water-heating equipment commensurate with the size of the establishment and the volume of business carried on. There is little danger, in most instances, of recommending too large an installation; in fact, the installation most likely to be made is one incapable of handling the load.

Storing utensils

The final consideration associated with dishwashing and sanitizing involves the storage of clean dishes and utensils so that they are not subject to contamination. Several conditions must be met if proper protection is to be provided:

> First, all china and glasses must be stored in a clean, dry place. China should be stored in cabinets or cupboards; glasses and cups should be inverted and stored on easily cleaned wire racks or in wire baskets. They should be stored at a sufficient height above the floor to be protected from dirt, dust, and splash.
>
> Second, silverware should be stored in partitioned bins, preferably of metal. Knives, forks, and spoons should be stored separately and so placed that the operator can remove them by the handle.
>
> Third, cooking utensils, pans, kettles, and similar equipment should be stored on appropriate shelves or hung from hooks well above the floor.
>
> Fourth, if single-service containers and utensils are used, they must be purchased in sanitary cartons, stored in a clean dry place, and handled in a sanitary manner.
>
> Fifth, all equipment and utensils used for dispensing foods, such as tongs, scoops, spatulas, dippers, and cutlery must be stored so that contamination is avoided. Scoops used for dispensing frozen desserts should be kept in a dipper-well supplied with running water.

Problems involving the proper handling, storage, and protection of clean dishes and utensils are frequently encountered in the average food establishment. Stress must be constantly placed on this aspect of sanitary maintenance and upon the necessity for storing clean dishes, utensils, and containers in clean, protected places.

SANITARY MAINTENANCE OF THE PREMISES

The general maintenance of the food establishment premises is of utmost importance if food is to be prepared and handled in a sanitary manner. While all of the material previously discussed has a direct bearing upon sanitation as a whole, other points remain to be considered.

One provision that should be included in a local food ordinance is that any person or company wishing to open a new food establishment make application to the health department for a permit to do so. Even in centers where careful control is maintained, it frequently happens that a person rents a vacant building and begins to convert it into a food or drink-handling establishment without consulting the health department. Generally such an individual has an honest intention and begins alterations in a manner most expeditious to him, only to find later, when application is made for an operating permit or license, that certain conditions do not comply with the food ordinance. This is an unfortunate occurrence for all concerned and must be avoided. When application is required for new buildings or for alterations of buildings or reconversion to other uses, provision is made in most city building codes for the issuance of a building permit. When such provision exists, it is highly desirable that a working agreement be made between the office of the building or safety engineering department and the health department so that the latter will be informed when the permit is issued. This then allows contact with the owner or prospective occupant and permits plans to be discussed and proper guidance given in conformity with the food ordinance. In fact, in actual practice, sanitarians carrying on routine field work should inquire as to the prospective use of commercial property being constructed or altered. Then, if the building is to be used as a food establishment, the work may be at a point where plans can be altered to comply with health department sanitary specifications.

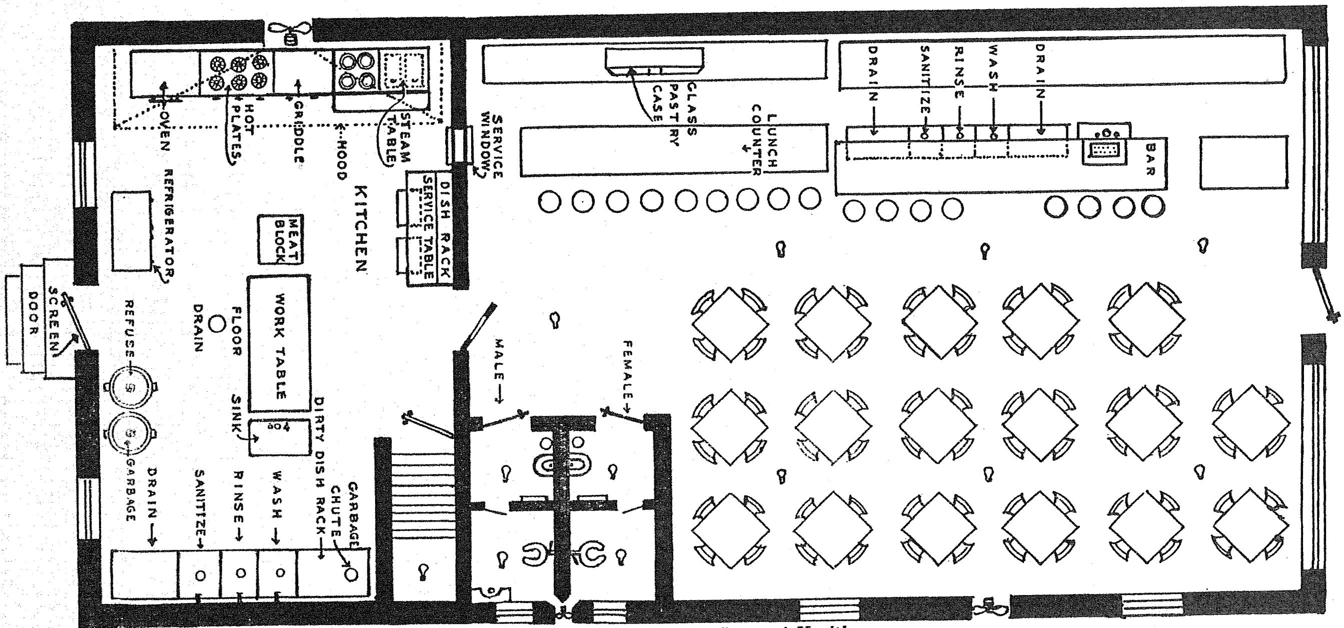
In this connection it is well to have a set of model plans available to submit to contractors or to others involved in the construction business. While it is appreciated that standardization is not as readily accomplished in food establishment layout as in milk plants, a plan showing the essentials of arrangement serves a useful purpose as an example of what is desirable. Because it is easier to visualize require-

ments from a drawing or blueprint than from words, the following plan (Figure 52) is suggested *strictly as a guide.* Building sizes and the type of business to be conducted in the building will of course make variations necessary. Consequently, it must *not* be assumed that the plan shown herein is suited to all food or drink-handling places. This plan, prepared by the Bureau of Sanitation of the Toledo, Ohio, Department of Health, was created basically to serve as a guide; it was blueprinted as a wall chart measuring 45 inches long by 30 inches wide; on the outside edges of the chart all the main items of sanitation were printed, but these are not included in the drawing shown herein. One or two minor changes have been made by the author to conform to current food establishment standards, possibly not in effect when the original chart was made.

It has been emphasized up to this point that plans for food or drink-handling establishments should be reviewed by the health department so that operation will be efficient and sanitation promoted. There are many other features bearing upon construction and operation facilities which should be considered. The following have been chosen as salient points, most of which are quite well defined in modern food ordinances.

Floors

In nearly all legislation regulating food establishments it is stipulated that floors shall be of such construction that they are smooth and of a material that is easily cleaned. While it is not within the province of an ordinance to require any one type of floor, the sanitarian should be in a position to advise the kind that is most serviceable and will lend itself to proper maintenance. Floors in kitchens and work rooms generally receive the heaviest wear and should therefore be of a material capable of withstanding it. Experience seems to indicate that flooring named in the following order will give the most satisfactory results: floor tile, terrazzo, matched hardwood flooring, heavy-duty linoleum sealed to the floor, and concrete. Asphalt tile is quite commonly used, but it must be the grease-resistant type; otherwise, grease carried from kitchen and work room on employees' shoes will cause it to soften and disintegrate. It is suggested that floors be curbed with a six-inch curbing around walls, the juncture to be coved to prevent water-soaking at edges.



Adapted from drawing supplied by the Bureau of Sanitation, Toledo, Ohio, Dept. of Health

Figure 52. Floor plan typifying many desirable features in a medium-sized restaurant. The layout shown is suggested purely as a guide and not necessarily as a model

Walls and ceilings

The construction of walls and ceilings has a definite relationship to the general appearance and sanitary maintenance of the premises. A smooth surface, preferably painted, with a light-colored oil base paint, or, in any case, walls of a type easy to keep clean, is necessary. There are many decorative materials now available and commonly used in serving and dining rooms which fulfill requirements and enhance the appearance of an establishment. In general, the construction of walls and ceilings where food is prepared and utensils are washed, as well as their proper maintenance, is of prime concern to the sanitarian. Walls of glazed tile are excellent, but smooth plastered surfaces are also satisfactory. The use of wood and wall board is to be discouraged because such materials may warp and are not impervious. All walls up to a point where they are subject to splash or spray must be of a durable, smooth, impervious material. This is particularly true for those adjacent to sinks, dishwashing machines, mixers, ranges, and steam tables. In all kitchens at some time liquids and food particles spatter on walls, and it is essential that smooth surfaces be provided so that such contamination can be removed easily. Equipment of any kind should be located, as far as practical, about eighteen inches away from walls or should be on casters for ease of moving. Periodic redecoration is of course necessary, with washing of soil from painted surfaces done regularly. During preparation for painting the workman should be instructed to fill in all pits, holes, cracks, and seams with filler. The painter actually observes the entire surface of walls and ceiling and can do a great deal to rid the food establishment of insect and rodent harborages.

Doors and windows

This item pertains to the screening of openings leading to the outside, as a means of preventing the entrance of flies. While screening of doors and windows is a general practice during seasons when flies are present, operators often install doors too lightly constructed. Sanitarians should urge them to provide a well-braced, substantial door hung on sturdy hinges; hinges with springs or a spring in the center of the door are recommended. A light door, even though new, will seldom go through a season without sagging, and flies will gain

easy entrance around the frame. Sixteen-mesh screen or plastic cloth should be used as screening material. Doors should be made to open outward if possible and should be self-closing. When an entrance is so located that it opens directly on the street, the provision for an outward-opening screen door generally cannot be met because of the danger of injury from the swinging door to passers-by. In such instances large power fans, sometimes known as aereo or whirlwind fans, may be placed near the entrance as a fly-repellent measure. It should be emphasized that a sanitary environment both inside and outside the food establishment will greatly assist in combating the fly hazard.

Lighting

The necessity for an ample quantity of evenly distributed light is constantly being more fully appreciated. Emphasis has been placed on the importance of light in schools and in industry, particularly as a means of increasing efficiency, lessening fatigue, and preventing accidents. These same benefits can be translated in terms of restaurant needs, with the added benefit of promoting cleanliness. Some improvement in food establishment lighting has accrued from the quite general use of fluorescent lights, but much is still needed. Adequate lighting of kitchens and work rooms, especially, is a subject needing more careful attention by sanitarians.

The most accurate way of measuring light is by means of a light meter, and this should be a standard piece of equipment in all health departments. A minimum of ten foot-candles of light should be provided on all working surfaces in rooms used for food preparation and where dishwashing is done. Frequently it is necessary to supply extra light fixtures near or directly over equipment to improve visibility. The lighting of hallways, dressing rooms, and toilet rooms is likewise important as a means of promoting general cleanliness. In storerooms present standards indicate that lighting equivalent to four foot-candles measured thirty inches from the floor is sufficient. If natural light is provided, the window area should be equal to ten per cent of the floor area, although this is not always an infallible standard inasmuch as the location and spacing of windows for uniform light distribution are important. Obviously, windows must be kept clean to admit the maximum amount of daylight.

Ventilation

Ventilation of restaurants is a subject upon which information is meager and specifications only general in nature. Most ordinances state that ventilation shall be adequate or that the premises shall be well ventilated, both statements leaving much to be desired. While the ventilation of eating and drinking establishments may have more esthetic than sanitary significance, certain facts must be recognized. First, where large groups of people congregate, as in most eating and drinking places, both the changing and the movement of air are beneficial. Next, cooking odors from the kitchen penetrate to dining rooms and become objectionable to patrons unless hoods are installed over ranges or exhaust fans provided. Experience has shown that hoods over ranges must be vented to the outside air and that the stack should extend about two feet above the highest part of the roof of the establishment and be vaned to properly dissipate the fumes. Frequently a blower is required in the vent pipe to cause a draft to remove heavy grease- and smoke-laden air. Hoods and fans in the kitchen also assist in ventilating the entire premises and will take out of the kitchen and dining room some of the stale air.

The sanitarian must exercise judgment in connection with ventilation, but the requirement that there be some means of letting out foul and smoke-filled air other than by doors and windows is a reasonable one. Specifying the number of air changes for a given time interval or the size of exhaust openings and the capacity of exhaust fans may be incorporated in ordinances in the future, but at the present time at least the adequacy of ventilation in an establishment is left largely to the judgment of the sanitarian.

Refrigeration

The important part good food refrigeration plays in a food control program cannot be over-emphasized; in fact, its position is outranked only by the food itself and by handlers who prepare and serve it. Innumerable instances are on record where lack of refrigeration or failure to utilize available facilities properly has been an important contributing factor in outbreaks of food poisoning.

Food refrigeration has for its primary purpose the preservation of food by arresting metabolism, bacterial growth, and enzymatic

action. While control in all three instances contributes to the healthfulness and palatability of food, the one of most importance in food sanitation work is that relating to the control of bacterial growth through low temperatures. With the advent of mechanical refrigeration, temperature control has been greatly improved; in fact, mechanically operated boxes are so common that their presence and function in a food store or restaurant are sometimes taken for granted. Such a concept should be avoided, since even the best equipment through lack of care alone may become inefficient and fail to accomplish its intended purpose. Bearing upon this point is the result of a survey made by the author of three hundred restaurants, in 26 per cent of which refrigerator temperatures exceeded 50° F. Therefore, a component part of each food establishment inspection should be a careful determination with an accurate thermometer of the temperature maintained in every refrigerator where perishable foods are stored. Not only is such a check valuable from the public health viewpoint but it will impress upon the proprietor the importance of refrigeration and offers an opportunity to emphasize that his refrigeration equipment must be correctly maintained and adjusted properly to meet effective temperature requirements. While 50° F. is generally accepted as the maximum allowable temperature for the storage of many perishable foods, a temperature several degrees lower is both preferable and desirable. Table VIII shows the recommended retail storage temperatures in degrees Fahrenheit for a variety of foods.[28]

From this table it can readily be seen that in a large majority of cases a refrigeration temperature below 50° F. is recommended; in fact, for fresh meat a range of 34° to 40° F. is recommended, and for poultry 29° to 32° F. These data emphasize that the type of food under refrigeration is largely the determining factor for proper temperature, and that a single temperature standard which fails to appraise the kind of food being refrigerated is not a sufficient criterion.

A second point of interest to the food sanitarian is the amount and kind of refrigeration available and how it is used. While no standard ratio of refrigerated space to volume of meals served daily has been developed, due to the many kinds of restaurants and stores with their variety of merchandising methods, it is of interest to note the several

TABLE VIII. Recommended retail storage temperatures

	Degrees F.		Degrees F.		Degrees F.
Fresh fruits:					
Apples	38–42	Dates	55–60	Oranges	50
Avocados	40–45	Figs	40–45	Peaches	50
Blackberries	42–45	Gooseberries	45–50	Pears	40
Cantaloupe	45–55	Grapes	40	Pineapples	50
Cherries	40	Grapefruit	50	Plums	40–45
Cranberries	40–45	Melons	40–45	Raspberries	40–45
Currants	40–45			Strawberries	42–45
Fresh vegetables:					
Artichokes	45	Celery	45–50	Peas	40–45
Asparagus	40	Corn	45	Peppers	40–45
Beans	40–45	Cucumbers	45–50	Potatoes, white	36–40
Beets	45–50	Eggplant	46–50	Potatoes, sweet	55–60
Broccoli	40–45	Endive	45–50	Radishes	40–45
Brussels sprouts	40–45	Lettuce	45	Rhubarb	45–50
Cabbage	45	Mushrooms	55–60	Spinach	45–50
Carrots	40–45	Okra	40–45	Sauerkraut	36–38
Cauliflower	40–45			Tomatoes	45–50
Meats:					
Bacon	36–40	Hams	36–40	Pork	36–40
Beef	38–42	Lamb	36–38	Poultry	29–32
Bologna	36–40	Lard	40–45	Sausage	36–40
Chicken	35–40	Liver	36–38	Tongue	45–50
Corned beef	36–40	Mutton	34–42	Veal	36–40
Other products:		Cheese (cont'd)			
Beer	45–48	Skim milk	48	Fish, fresh	25–30
Bread	46–50	Swiss	40	Honey	45–50
Cheese		Whole milk	34–36	Lobsters, boiled	36–40
Brick	30–35	Chocolate	60–65	Lobsters, live	39–45
Cheddar	36–38	Cider	46–50	Milk	40–45
Cheshire	38–40	Cream	40–45	Molasses	45
Limburger	42–44	Dough	46–50	Oysters	32–35
Neufchâtel	50–52	Eggs	38–45	Oysters, opened	23–30
Roquefort	39–41				

types of refrigerating systems which may be used in a single restaurant. Classified, they are as follows:[10]

1. Drinking water and beverage cooling.
2. Storage of meats, fish, vegetables, and dairy products. In this case the size of the restaurant generally determines whether all products are held in one refrigerator or whether separate boxes are maintained at different temperatures for each class of food.
3. Manufacture and storage of ices and frozen desserts.
4. Making of bulk or cube ice.

5. Making and storage of candies in certain types of restaurants.
6. Storage of ingredients for a baking department.
7. Refrigerated cafeteria displays.
8. Frozen food storage cabinets.

Judging the adequacy of refrigeration requires an intimate knowledge of the kind of business conducted plus frequent observations of the refrigeration equipment under conditions of practical use. Failure, for example, to provide adequate low temperature refrigeration for fresh meat because a box is used for general-purpose storage and opened frequently with resulting temperature fluctuations and increases would point to the need of additional equipment devoted to meat storage alone. When sufficient facts and data have been accumulated, inadequacies should be pointed out to the proprietor and recommendations made for correcting such deficiencies as may be found.

Closely allied with adequacy is, of course, the question of effective use. Certain practices reduce the efficiency of refrigeration, and in turn affect the food. These should be noted by the food sanitarian and advice given to avoid them. Food should not be stored on top of cooling units or in the drip pan below the unit, since such a practice restricts air circulation and may contribute to frosting of the unit. Refrigerator shelves should not be covered with paper, linoleum, or similar material, since this causes stagnation of air and creates excessive sweating of products and increased operating expense.[23] The storing of fresh meat so that there is a complete circulation of cool air around it is to be recommended. Hooks upon which meat is hung in storage refrigerators should be of the movable type to allow proper spacing of meat to avoid contact of one cut with another. Placing large amounts of food in a single container should be avoided, since cold air will not reach the innermost layers rapidly and refrigeration will thus be delayed. For the same reason sliced meats should be stored in layers not exceeding four inches.

The possibility of contamination reaching the refrigerator and its contents should be investigated. Drains from refrigerators should not be piped directly to sewer or waste lines. There should be a break in the line so that drainage from the refrigerator will go to a small sink or open hopper and this fixture trapped and properly sewer-connected. This precaution is necessary to eliminate the possibility of sewage

backflow reaching the refrigerator. In lieu of such an approved drain connection, water-tight drip pans may be used.

In addition to these points there is the cleanliness of the refrigerator to be considered. Observation quickly reveals the condition of side walls, trays, racks, doors, gaskets, and fixtures. The refrigerator must, of course, be given a thorough cleaning at frequent intervals with warm water containing a good detergent. Wiping the interior of the box, after it has been cleaned, with a cloth moistened in a bactericidal solution is to be recommended. For deodorizing, charcoal hung in net bags will absorb odors. Gaskets which are worn and door fittings and hardware in poor condition should of course be replaced or repaired to make all doors tight-fitting.

The increased use of ultraviolet light, especially in meat refrigerators, is another matter of interest to the food sanitarian. The question of using ultraviolet light as an adjunct to refrigeration is quite controversial; therefore, its limitations as well as some beneficial effects claimed for it should be recognized. Ultraviolet light in conjunction with refrigeration is used mainly as an inhibitor to microbic growth, since the germicidal value of radiations of the mercury spectrum at wave length 2537Å is known to be effective. The best bactericidal lamps emit about 80 per cent of their radiations at this wave length.[18, 19] If initial infection and bacterial surface contamination on meat are low, ultraviolet light is an effective means of destroying organisms present. One writer has suggested that destruction is accomplished if initial infection does not exceed 1,000 bacteria per square centimeter. Ultraviolet radiation produces a slight coagulation of meat surfaces sufficient to reduce evaporation or shrinkage materially, reduction amounting to several per cent. Higher relative humidities, also a factor in reducing evaporation from meat, can be maintained when ultraviolet light is used, but humidities of above 90 per cent without radiation involve, after a few days, surface infection by bacteria or mold or both, with subsequent loss from trimming.

Reduction of air-borne infection and removal of objectionable odors from cold-storage boxes are also claimed when ultraviolet light is used. Ozone, having germicidal properties, is produced in low concentrations when ultraviolet light is used. Radiations below 2000Å will convert a portion of the oxygen to ozone and if bacteria are in single layers on food surfaces and not covered with organic material,

1.5 p.p.m. in three to four hours kill 99 per cent of the bacteria and 0.5 p.p.m. 90 per cent.[20]

Appraising the use of ultraviolet light further, we find several limitations. One of the first is that initial infection and surface bacterial contamination be low. The number of layers of living or dead bacteria on the surface being radiated is a determining condition of control.[26] Experimental work has demonstrated that effective bacterial destruction does not occur when more than two layers are present or when organisms are protected by organic matter. Ultraviolet rays have little penetrating power so that even very thin films of dirt or moisture may shield the microorganisms from the damaging effect of the radiation. "A film of beef juice 0.2 mm. thick reduced the intensity of ultraviolet light a thousandfold."[44]

The question of rancidity must also be recognized. Butter, cream, lard, and fat sausages exposed to direct radiation will become rancid and must be protected by storing in a covered container. Fats of fish likewise are adversely affected by short wave lengths of light and by ozone. The ozone generated in the presence of ultraviolet light is of exceedingly low concentrations, at most a few tenths of 1 p.p.m. of air, and its germicidal value cannot be considered particularly significant unless the exposure time is a substantial number of hours. Layers of bacteria and organic matter also reduce its bactericidal powers.

Another limitation involves meat surfaces that are in the shade or are shielded from the direct line of radiation. Even surface destruction of microbic life is not accomplished when such surfaces are outside the line of radiation, although advocates of radiation have claimed that ozone will reach these surfaces and destroy organisms. However, a moderate air movement is necessary to accomplish this and slow-moving air is not provided in all refrigerators where ultraviolet light is installed.

In some cases operators have been led to believe that higher refrigerator temperatures could be used safely when radiation was employed. For the several reasons mentioned above, this is of course erroneous, and even though higher temperatures and high relative humidities have been used in a certain commercial tenderizing process, both have been carefully supervised by trained technicians and more than ordinary controls provided. To attempt either tenderizing meat

or preserving it on the premise that ultraviolet light is the main factor in control is a mistake and should be so recognized by the ordinary user.

Because refrigeration is one of the important and essential factors in the proper care and handling of perishable foods, it deserves careful and regular attention on the part of all food sanitarians. High standards of operating efficiency and maintenance should be emphasized to assure maximum benefits in terms of safe, wholesome food.

Toilet facilities

Sanitary means for the disposal of human excrement and liquid wastes must, as is readily appreciated, be provided in every food- or drink-handling establishment. The ideal arrangement is properly installed plumbing within the establishment and a connection to a public sewerage system. There are certain other points about such facilities which must be considered.

The food ordinance recommended by the United States Public Health Service now contains the wise provision that for food or drink-handling establishments newly constructed, or remodeled and opened as new places, toilet rooms shall not open directly into any room in which food, drink, or utensils are handled or stored. This necessitates the use of an intervening room or vestibule equipped with tight-fitting, self-closing doors and large enough so that both doors cannot be opened simultaneously by the same person (see Figure 53). State restaurant regulations in Tennessee specify that such a vestibule shall have a minimum floor area of 18 square feet. Other provisions require springs or checks to make toilet room doors self-closing, proper sanitary maintenance of both the room and the toilet, and light and ventilation to the outside air.

In addition, the labor laws of many states require that separate toilet facilities be provided for men and women employees. Laws regulating places serving alcoholic beverages regularly prescribe separate toilet facilities for patrons of both sexes. The question sometimes arises whether separate toilets for patrons and for employees should be provided. This is an issue about which health departments need not be concerned, as it is a matter for the proprietor to decide. In large establishments, however, such separate facilities will be found, but health departments are concerned mainly with proper toilets and their

sanitary maintenance for employee use. If toilet facilities for patrons are provided by the food establishment owner, the responsibility of maintaining these public comfort stations rests on him. If they are located within the food establishment, they must be equipped with lavatories, soap, individual towels, and toilet paper, and have janitor service. Finally, in every toilet room in every food establishment there should be posted a conspicuous legible sign directing all employees to carefully wash their hands before resuming work. Stenciling of handwashing signs on the wall is recommended, since other types may be torn down.

Lavatory facilities

Adequate and convenient handwashing facilities are of paramount importance and must be provided in every place where food and drink are handled. If employees are to develop clean habits, the owner of an establishment must meet his responsibility and see that lavatories,

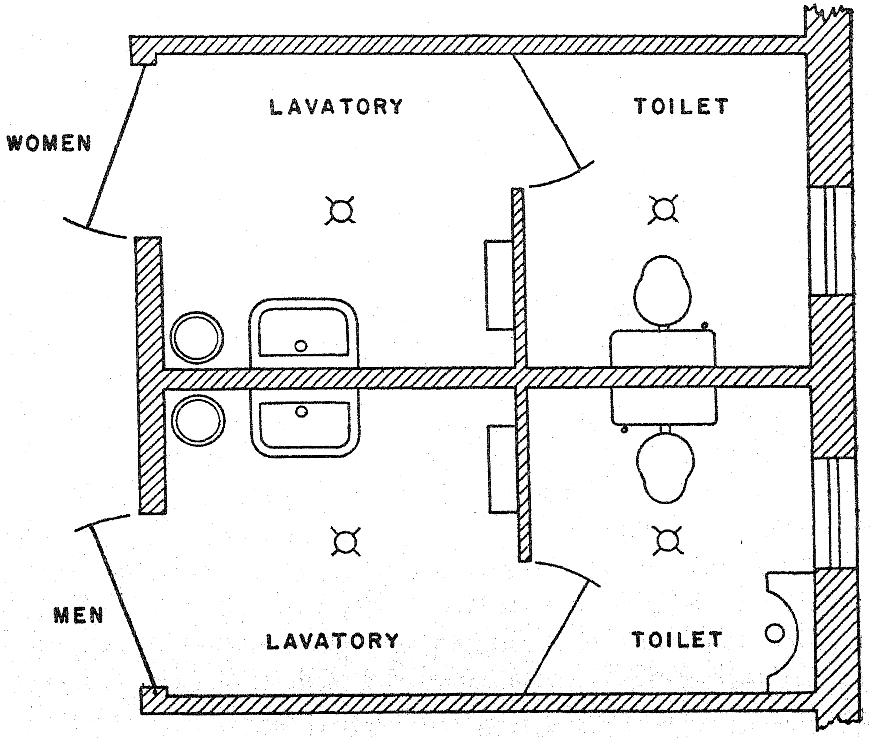


Figure 53. The use of a vestibule prevents a direct opening from toilet to restaurant

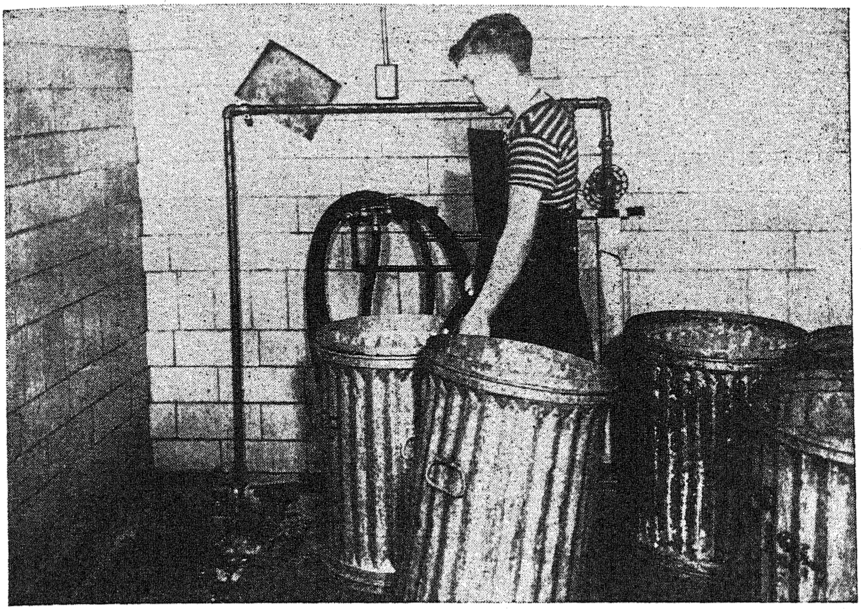
running hot and cold water, soap dispensers, and approved sanitary towels are provided. It is preferable that wash bowls be equipped with mixing faucets so that water can be properly tempered. The use of faucets operated by foot pedals should be encouraged. Experience indicates that lavatories are likely to be maintained in better condition if they are outside the toilet rooms. If a vestibule leading to the toilet room is provided, the lavatory may be located there, or it may be set on a wall or partition adjacent to the toilet.

The question frequently arises whether the continuous pull-down type of cloth towel dispensed from a cabinet can be considered sanitary as an individual towel. Opinions differ on this point. The State Health Department of Kentucky suggests fifteen inches as the minimum allowable length for each fresh portion as it is pulled from the cabinet. It should be remembered, however, that these dispensers are designed to give an individual length of towel to each user and the main basis for criticism is that they are not inspected by the management frequently enough to assure a sufficient quantity of unused towel on the roll: when the toweling has run out, the last individual length exposed becomes a common towel. However, it would appear that if the cabinet is refilled as required, the customer using this facility properly will obtain a clean individual section and the device can be considered satisfactory.

There should be at least one lavatory in every kitchen or food-preparation room. Normally, few employees will walk from one section of an establishment to another to use a lavatory; rather, they will wash in the first sink that is handy, usually the one used for dishwashing. It follows, therefore, that an essential piece of kitchen equipment is a hand sink, preferably of the pedestal type, installed where it will serve a real need.

Dressing or locker rooms

The absence of separate, well-lighted, well-ventilated locker rooms is a frequent defect in restaurants; consequently employees' clothing may be found hanging in kitchens, in toilets, and in storerooms. Usually space can be found or partitions erected so that a room can be made for this purpose. If lockers are used, they should be placed back to back, and should be constructed with slanting tops to prevent storage of articles on top of them. The need for dressing rooms and



Courtesy Minnesota Dept. of Health

Figure 54. A separate room for washing and storing garbage cans. Running hot and cold water, impervious walls and floors, and proper drainage greatly aid in the sanitary maintenance of garbage containers

lockers is a point to be stressed when a new establishment is being built or when remodeling is contemplated. Each such room should have a container for soiled linen, aprons, and uniforms.

Garbage and Refuse Disposal

The sanitary storage of garbage and refuse awaiting disposal is a commonly neglected phase of food establishment sanitation. Battered, leaky cans with covers missing are too frequently encountered. It is the exception rather than the rule to find garbage cans washed and kept reasonably clean. One significant reason for this is an almost total lack of a suitable place where they can be cleaned. What is needed is a separate garbage room where filled cans can be stored until collected. This room should have impervious walls and a concrete floor (see Figure 54). At one side there should be a gutter sloping to a drain. Hot and cold running water should be supplied at an outlet to which a hose can be connected, so that after cans are emptied

they can be flushed out regularly. Can storage outside the building will be materially improved if a concrete platform is constructed upon which the cans can be set. A pipe railing around the platform is recommended, with an opening left at one end so that cans may be conveniently removed for emptying. To prevent loss of can covers, a strong chain run through the cover handle and bolted to the building is a feasible scheme.

Refuse in the sense used here refers to waste paper, crates, tin cans, glass, and similar discarded articles. An attempt is frequently made to burn papers in a flimsy outdoor incinerator (usually illegal under fire prevention laws). Often there is a mixture of non-combustible trash included, and as a result the burning generally leaves the yard cluttered and unsightly. Unless burning of papers, boxes, crates, and so on can be done in a properly constructed incinerator or in a furnace, it should be discouraged. If a refuse collection service is available, this material can be quite satisfactorily held in a rat-proof concrete or concrete-block box equipped with a tight metal door; or a small corrugated building on a rat-proof concrete foundation may be built, with a metal-clad door large enough to facilitate loading of refuse into a vehicle for removal. If space does not permit the use of these devices, storage must be in covered metal containers, preferably of a size that can be readily handled by the collection service.

Needless to say, this one phase of restaurant sanitation has a decided influence upon the control of flies, rodents, and odors.

SUMMARY

Food establishment sanitation is an important phase of public health work, and where well-organized programs are in effect effort expended in educating and instructing operators in correct methods will give encouraging results. In this chapter an attempt has been made to point out the kind of information the sanitarian must have in order to make his work effective. Of necessity the work must be largely educational, for it is surprising and revealing how little information of a real public health nature is possessed by many operators.

The need for improvement in food-handling equipment is real, and the manufacturers of such equipment would do well to consult with public health engineers and sanitarians, just as manufacturers of

milk plant equipment have done. A few examples of poor equipment may be cited: basket-type whippers or beaters with hollow handles, ice cream dippers not easily taken apart, syrup pumps with threads exposed to food, overhead drive mixers in which grease from packing boxes can drop into food, soda fountains with only two sinks instead of three and with old-fashioned built-in spray rinses, ice cream cabinets without dipper wells, slicing machines not easily dismantled, knives and cutlery with cracks between blade and handle where grease and dirt may accumulate, sugar dispensers with unprotected openings easily contaminated by flies, ineffectual counter glass-washing machines, dishwashing machines with practically no provision for adequate sanitizing of dishes, and enameled utensils which chip easily. The sanitarian can do much by pointing out such defects and advocating seriously needed improvements to make food preparation and serving more sanitary.

XIII

THE INSTRUCTION AND TRAINING OF FOOD HANDLERS

THE instruction of food handlers in the essentials of hygiene and sanitation relating to their occupation has now been generally accepted as integral with and necessary to a food control program and is proving to be a productive procedure in public health education. Within the past decade many health departments have organized successful educational programs, and interest in this type of activity is increasing rapidly. For many years health officers advocated the physical examination of food handlers, believing that such a procedure would serve to materially reduce food-borne infections, but epidemiological evidence does not substantiate this theory. The thinking of many health officers and sanitarians regarding physical examinations was crystallized in a paper presented before the American Public Health Association in 1937 by Dr. William H. Best[8] of the New York City Health Department. Dr. Best questioned the efficacy of routine physical examinations, pointing out that generally such examinations were of a cursory nature, that they did not reveal conditions that might be conducive to the transmission of disease through food, that they gave no assurance that the person examined would remain free of communicable disease during the tenure of the certificate, and that, even if the examinations were carefully made and supplemented by serological and bacteriological tests, the cost was prohibitive and not commensurate with the public health benefits obtained. Even now there is not complete unanimity of opinion regarding the physical examination requirement. Periodic medical examinations are still given in many areas where community opinion favors them, where local or state laws require them, or where the incidence of certain communicable diseases is high and food workers are used as a case-finding group. However, in few modern food ordinances does one find a requirement for the examination of all food handlers on a routine basis; rather, examinations are recommended on the basis of epidemiological evidence or other indications. This change in policy has resulted in increased emphasis on the instruction of food handlers.

The logical assumption has been that if food handlers are taught the elements of personal hygiene and proper health habits, are instructed in the fundamentals of safe food-handling practice, and are shown the various channels through which contamination of food and drink is possible, and how to avoid it, the health of the public will be better protected than by indiscriminate examinations which of themselves are of questionable value. The situation was quite tersely summarized by Dr. J. L. Pomeroy, of California, in this statement: "It isn't the hazard of ten waitresses contaminating the glassware that serves 1,000 people that is a matter for concern. It is the 1,000 persons whom the ten waitresses have served; there is the real danger."[6]

DEVELOPMENT OF EDUCATIONAL PROGRAMS

When programs of instruction were first being formulated it was immediately apparent that there were few precedents of any kind to follow. Some previous work had been done by certain municipalities, but it was not particularly wide in scope. Visual aids in the form of suitable motion pictures and appropriate slides for illustrative purposes were almost wholly lacking. To overcome this deficiency, work was begun in Texas about 1938 through a cooperative plan developed between the State Health Department and the State Department of Vocational Education. This resulted in the development of a training course incorporating nearly all of the essentials of good food-handling practice. The course proved to be an outstanding contribution and a pattern in content quite generally followed. In addition, two motion pictures, "Ham An' " and "Slingin' Hash" were produced by the state of Texas under the supervision of Lewis Dodson, then consultant in vocational training for the Texas State Health Department.*

At about this same time a program was being developed on a municipal basis by the Flint, Michigan, Department of Health, where classes for food handlers were started early in 1938. A provision of the city food ordinance requiring all food handlers to be medically examined at least once every six months had been in force for sixteen years, but this was gradually abandoned in favor of instruction. In fact, a provision making attendance mandatory at semi-annual in-

* A new 16-mm. film in sound and color, entitled "From Hashslinging to Food-handling," was released by the Texas State Health Department in May 1945.

struction periods was added in 1939 as an amendment to the Flint food ordinance. As a further aid in the promotion of this program, the National Tuberculosis Association entered into a cooperative agreement with the Flint Department, rendering financial and technical assistance. In 1940 a 16-mm. silent film on restaurant sanitation was produced, entitled "Eating Out." The film has been well received and is being used by many other health departments in their classes of instruction.

Shortly afterwards the State Health Department of New York produced an excellent 16-mm. sound film entitled "'Twixt the Cup and the Lip," which has since been widely used for its effective treatment of the manner in which respiratory disease may be spread by unclean dishes and eating utensils. Another sound film on food handling, entitled "It's No Picnic," was produced at about this time under the supervision of W. David Lewis of the Albuquerque, New Mexico, Health Department. This film deals with food poisoning and the danger of infection from improperly handled and contaminated food. Still another valuable contribution was made to food-handler instruction when a series of four sound slide films entitled "Our Health in Your Hands" was released by the United States Public Health Service during the summer of 1945. These film strips cover several phases of food sanitation, as the following subtitles indicate: "Germs Take Pot Luck"; "Service with a Smile"; "In Hot Water"; and "Safe Food for Good Health."

Considerable credit should also go to the Public Health Committee of the Cup and Container Institute of New York City for its interest in food-handler instruction. Publicity given to successful programs undoubtedly stimulated a desire on the part of health officers and sanitarians to organize similar programs. This organization has likewise promoted two good film productions on the general topic of drinking-glass and utensil sanitizing: one is a sound film strip called "In Your Hands"; the other, released in 1943, is a 16-mm. sound film in color called "The Danger Point."

Well-planned courses of instruction for food handlers have been widely accepted as an effective means of helping to insure the safety of food and drink served in public places. In fact, in the 1943 edition of the Ordinance and Code Regulating Eating and Drinking Establishments recommended by the United States Public Health Service,

control officials are urged and encouraged to institute training courses for food handlers. The Public Health Service has also issued an excellent pamphlet, written in attractive and popular style, entitled "From Hand to Mouth"; it is admirably suited for distribution among food workers. So-called "food schools" are now nation-wide in scope, with more and more communities adopting them.

PLANNING AND CONDUCTING FOOD-HANDLING CLASSES

There are certain well-defined steps which must be followed if a course of instruction is to be successful. One of the first, of course, is the assembling of applicable subject matter for presentation. The material for lectures and classes must be carefully selected and organized on the basis of its practical application and usefulness. Points that will contribute most to the food handler's understanding of sanitary requirements, the reasons for them, and how he may apply them in his work are those to be stressed. A suggested outline for course content will be found in the Appendix, page 271.

The next step is to enlist the cooperation of owners and operators of public eating and drinking places. If there is an active association of hotel, restaurant, and tavern operators, or a local branch or section of the National Restaurant Association in the community, certain of its officers and members should be consulted with a view to lending their cooperation and support; or the aid of the local Chamber of Commerce may be enlisted. Generally it is not difficult to stimulate interest, since operators of the better-class establishments are progressive and anxious to do all they can to improve food handling and sanitation within their establishments. After the proposal has been discussed with these individuals, the next step is to invite them to attend demonstration sessions so that they may know in detail the objectives and content of the proposed course. This will show the need and value of instruction and arouse their interest so that they will encourage their employees to take advantage of the training. In Texas, proprietors were invited to take the complete course of six two-hour periods. In Minneapolis, the Minnesota Restaurant Association, through its officers and executive secretary, collaborated closely with the City Division of Public Health: food-handler courses were started with a meeting attended by four hundred local restaurant operators and managers; during the two-hour session the pur-

pose of the course was outlined and typical food sanitation films shown; classes were then started the following week, with very satisfactory results. These seem good examples to follow, since it is especially important to have restaurant owners and supervisors fully informed and instructed concerning the course content. It is decidedly advantageous to have a restaurant association assist in sponsoring the program; in fact, printed announcements, if used, should carry their endorsement along with that of the health department.

Obviously, a suitable meeting place must be selected. This should be in an accessible, central location. High school auditoriums, council chambers, county buildings, hospital auditoriums, or, preferably, a lecture room within the health department quarters when space is available may be used for the meetings. Another good plan is to hold meetings and classes in a restaurant. Larger ones usually have a separate meeting room that can be closed off. An area in a city can be selected where there are several eating and drinking establishments within a block or two. In addition to the employees of the restaurant where the meeting is held, others from places in the immediate vicinity can be invited. Obviously, the whole force cannot attend the same meeting, but generally there is a lull in business between the lunch and dinner periods when some of the help can be relieved to attend classes. If this plan is followed, considerable time must be allowed for personal contact with restaurant operators in the area selected; this usually requires that at least one person from the health department devote a major portion of his time to the project.

After the time and place for meetings have been determined, the cooperation of the local press should be solicited. It is recommended that a press release be prepared to serve as a guide to the reporter or editor: it should indicate why the course is needed, what it is designed to accomplish, and when and where it will be held. Members of the press should be invited to attend all sessions. Newspaper publicity is of real value and should be utilized to the fullest extent.

Once a course has been started, a regular schedule may be established. This can be done more readily in a municipality than in rural areas, since in the former the number of persons employed will be larger and the need for a continuing course to furnish instruction to new workers as they are hired will be greater. The number of class periods to be devoted to a complete course will vary from one locality

to another. In Texas[45] a course consisting of six two-hour periods was held; in Flint, Michigan, the course consists of four one-hour periods.[1] If a continuing course is given, classes should be held at the same hour on specified days so that a routine will be established to prevent misunderstanding and confusion on the part of those planning to attend.

Registration procedure

It is of course necessary to develop and use a registration procedure to keep a record of class attendance. This should be as simple and expeditious as possible so that there will be no delay in registering participants. One plan is to have a clerk take the registrant's name and place of employment as he presents himself; then, while the session is in progress, a registration card can be made out in duplicate. The original is given to the food handler at the end of the lecture; the duplicate is kept in a file. Some designation must be made on the registration card to indicate which of the lectures has been attended. A sample registration card is shown in Figure 55. The date of attendance is rubber-stamped on the card over the number designating which lecture in the series was attended. As will be noted, a brief statement of content for each lecture is printed on the reverse side of the card. The food handler is told to bring the card with him for the next lecture; if he should fail to do so, the duplicate file copy indicates his attendance history, and from this copy another original may be made and given him if desired (experience in Flint, however, has indicated relatively little difficulty in this connection). Where courses are not operated continuously, a less detailed system may be used by simply entering the number of the lecture or lectures attended against the registrant's name. However, in order to award certificates for course completion, an accurate registration system is necessary.

Quizzes, certificates, and awards

Many health departments conducting training schools for food handlers give oral quizzes at the end of the course, usually in the form of a true-false test. The exercise is voluntary, its main purpose being a review of the material covered to give the participant an opportunity to test himself on the subject matter which has been discussed.

FLINT DEPARTMENT OF HEALTH

Food Handlers' Instruction Course

Attendance Card

Date ______________________

Name ______________________________________

Address of Employment ______________________________

Have you had a Food Handlers' Card before? ______When? ________

KEEP THIS CARD—bring it with you to the next lecture

This card is for attendance record only

READ OTHER SIDE CAREFULLY

Attendance Record: 1 2 3 4

INSTRUCTIONS

Read Carefully

The course of instruction covering important points on food handling in relation to health and sanitation consists of the following lectures:

Lecture 1—"Public Enemies"—First Monday and Tuesday of each month.
(Common communicable diseases—bacteriology.)

Lecture 2—"Good Housekeeping"—Second Monday and Tuesday of each month.
(Equipment and utensil cleaning and sanitizing.)

Lecture 3—"Protecting Food"—Third Monday and Tuesday of each month.
(Display—storage—refrigeration of food.)

Lecture 4—"The Individual"—Fourth Monday and Tuesday of each month.
(Personal hygiene and cleanliness.)

Lectures begin Monday at 2:00 p. m. sharp—Tuesday evening at 8:00 p. m. sharp.

NOTE: If there are five Mondays and/or Tuesdays in a month, no lectures will be held on those days.

Satisfactory completion of this lecture course will entitle the individual to work as a food handler as long as approved food handling practices are carried out.

For credit toward your attendance, be sure to bring this card with you each time.

FLINT DEPARTMENT OF PUBLIC HEALTH

Courtesy Flint, Michigan, Department of Public Health

Figure 55. Sample registration card, front and back, for food-handler instruction course

Possible weaknesses in teaching methods will be brought out by observing those questions which are not correctly answered. A set of sample questions of a type which may be used is shown in Figure 56.

Some kind of certificate of recognition should be given those completing the course. A card approximately two and one-half by four inches, which is the size that will fit into a wallet or card case, is quite suitable. Sample certificates are shown in Figure 57. A certificate may be awarded only to those who have attended every session or to those who have attended all but one. In voluntary programs, presence at all but one class probably should be considered sufficient, but where it is mandatory, attendance at all classes is prerequisite to receiving a certificate. It has been reported in several instances that a course certificate has aided the holder in securing employment as a food handler.

As an incentive both to food handlers and to food establishment operators, a placard or poster may be awarded in recognition of the fact that all employees, or at least a high percentage of them, have received training. The placard may be posted in a conspicuous place in the establishment. Sample placards of this type are shown in Figure 58. If this kind of award system is used it is essential to have a continuing course of instruction, since the employment turnover in the average food establishment makes it necessary that facilities be provided to give training in food sanitation to new employees. It is obvious that the awarding of such a placard necessitates an appraisal not only of employees at work but of the general maintenance of an establishment as well. Then the placard should be awarded only when evidence indicates that desirable food sanitation standards are being maintained. If placards are used with these limitations in mind, they serve a useful purpose in encouraging careful food-handling practices.

An attempt has been made in this chapter to point out the value and need of well-planned classes of instruction for food handlers and how they can be organized. The outline of lectures in the Appendix may serve as a guide for those inaugurating this kind of activity. It should be borne in mind that careful planning is needed and that proper teaching techniques must be used, with material presented in a stimulating and interesting manner. If good groundwork has been laid and cooperation of all interested parties enlisted, a program of

Food Handlers' School, Department of Health

Review Questions—Session I

Explanation—The following exercise brings out some facts about bacteria, the prevention of food poisoning, disease control, food handling methods, and personal hygiene. An understanding of these facts is important for every person who works with food. Answers to these questions have been brought out in the class period.

Directions—Some of the statements below are true and some are false. Toward the close of the class period, the instructor will go over these with you to sum up and to help you remember the information covered. Which of the statements below do you believe true, which false?

1. Bacteria are living organisms too small to be seen with the naked eye and are measured in microns (about 1/25,000 of an inch). ________
2. Under favorable conditions some bacteria multiply every 20 minutes. ________
3. Bacteria do not need food, moisture, and a favorable place to grow. ________
4. High temperatures and certain chemicals kill bacteria. ________
5. The U.S. Public Health Service lists 62 communicable diseases, 25 (or 40 per cent) of which may be transmitted through faulty food and drink handling methods. ________
6. All bacteria are dangerous and harmful. ________
7. Intestinal diseases are often spread by carriers. ________
8. The most common types of food poisoning today are caused by harmful bacteria getting into our food. ________
9. A food handler who continues to work while ill can infect food which could cause an epidemic. ________
10. Covering the mouth and nose when coughing or sneezing is an important rule for all food workers to follow. ________
11. A thorough and careful washing of the hands with warm water and soap is a *must* after using the toilet. ________
12. Common towels are unsightly but are not a health hazard. ________
13. Many outbreaks of food poisoning have been caused by contamination introduced through promiscuous handling and fingering of food. ________
14. Personal cleanliness and clean practices rank among the first in any program to protect food. ________
15. Serving food and drink in a safe and sanitary manner must be the chief aim of every food handler. ________

Figure 56. A set of sample questions for food handlers

this type will be found successful and profitable. As a word of caution, however, an educational program must not be considered a substitute for reasonable and necessary enforcement, for both are necessary and one complements the other.

FOOD HANDLER'S WORKING PERMIT
DEPARTMENT OF PUBLIC HEALTH
Flint, Michigan
Division of Food and Sanitation

This is to certify that ______________________________

employed at ______________________________ has completed

a course of instruction in Food Handling, Hygiene and Sanitation, conducted by the Flint Department of Public Health, in accordance with the provisions of City Ordinance 222, Section 15, as amended.

Issued ____________ by the Flint Department of Public Health.
Date

This permit subject to revocation if approved food handling methods are not carried out.

By Authority of
EXECUTIVE HEALTH OFFICER

____
Signature of Food Handler

____
Director, Div. of Food & Sanitation

Courtesy Flint, Michigan, Department of Public Health

FOOD HANDLERS SANITATION CERTIFICATE
THE TEXAS STATE DEPARTMENT OF HEALTH
IN COOPERATION WITH THE
LOCAL HEALTH DEPARTMENT

CERTIFIES THAT ______________________________

HAS SUCCESSFULLY COMPLETED A TWELVE-HOUR COURSE IN SANITATION FOR FOOD HANDLERS.

GIVEN IN ______________________________ TEXAS

THIS ____________ DAY ____________ 19____

______________________ M.D.
STATE HEALTH OFFICER

______________________ M.D.
DIRECTOR LOCAL HEALTH DEPT.

Courtesy Texas State Department of Health

Figure 57. Sample certificates issued to food handlers completing a training course

Display of this card is permitted only when standards of sanitation and training are maintained

FOR YOUR

HEALTH PROTECTION

____

(Firm Name)

has cooperated with

the Utah State Department of Health and the local health department in having a minimum of 80 per cent of its personnel trained in the sanitary methods of food preparation and service. On the date specified below this firm was found to be complying with all prescribed sanitary laws and regulations.

Dated: ________________ 19 ____

By ________________________

This card is the property of the Utah State Department of Health and may be removed without notice

Courtesy Utah State Department of Health

Display of this card is permitted only when standards of training are maintained

Awarded for your HEALTH PROTECTION

(Seal of the State of Texas)

Issued for ____________________

this _____ day of _______________

19____

________________________ M.D.

Director, Local Health Dept.

________________________ M.D.

State Health Officer

This firm has complied with the standards prescribed by the Texas State Department of Health and the local health department for training its personnel in the sanitary methods of food preparation and service.

This card is the property of the State Department of Health and may be removed without notice

Courtesy Texas State Department of Health

Figure 58. Sample placards awarded to establishments whose employees received training in sanitary methods of food preparation and service

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American Journal of Public Health. Published monthly by the American Public Health Association, 1790 Broadway, New York 19, N. Y.

Association of Food and Drug Officials of the United States. Quarterly Bulletin. Published at 1098 W. Michigan St., Indianapolis 7, Ind.

Journal of Dairy Science. Published monthly by the American Dairy Science Association, Science Press Printing Co., Lancaster, Pa.

Journal of Milk Technology. Published bi-monthly by the International Association of Milk Sanitarians, Inc., Albany, N. Y.

Public Health Engineering Abstracts. Issued monthly by the U. S. Public Health Service (Government Printing Office), Washington 25, D. C.

Public Health Reports. Issued weekly by the U. S. Public Health Service (Government Printing Office), Washington 25, D. C.

The Sanitarian, a Journal of Sanitary Technology. Published bi-monthly by the National Association of Sanitarians, Inc., 206 W. Sixth St., Los Angeles 14, Calif.

Also there are many commercial and trade periodicals which contain excellent articles of pertinent interest; consult your public library.

PARTIAL LIST OF ORGANIZATIONS INTERESTED IN THE DAIRY AND FOOD INDUSTRY*

The Dairy Industry

American Association of Medical Milk Commissions, Inc., 1265 Broadway, New York 1, N. Y.

American Butter Institute, 110 N. Franklin St., Chicago 6, Ill.

American Dairy Association, 20 N. Wacker Drive, Chicago 6, Ill.

American Dairy Science Association, Ohio State University, Columbus 10, Ohio.

American Dry Milk Institute, Inc., 221 N. LaSalle St., Chicago 1, Ill.

American Public Health Association, 1790 Broadway, New York 19, N. Y.

* Some of these organizations have joint interests.

Association of Official Agricultural Chemists, Inc., P.O. Box 540, Benjamin Franklin Station, Washington, D. C.

Certified Milk Producers Association of America, 1265 Broadway, New York 1, N. Y.

Dairy Industries Supply Association, Inc., Albee Bldg., Washington 5, D. C.

Evaporated Milk Association, 307 N. Michigan Ave., Chicago 1, Ill.

International Association of Ice Cream Manufacturers, 1105 Barr Bldg., Washington, D. C.

International Association of Milk Dealers, 309 W. Jackson Blvd., Chicago 6, Ill.

International Association of Milk Sanitarians, Inc., State Health Dept., Albany, N. Y.

The Milk Foundation, 75 E. Wacker Drive, Chicago 1, Ill.

Milk Industry Foundation, Chrysler Bldg., New York 17, N. Y.

National Cheese Institute, 110 N. Franklin St., Chicago 6, Ill.

National Dairy Association, Brattleboro, Vt.

National Dairy Council, 608 S. Dearborn St., Chicago 5, Ill.

Paper Cup and Container Institute, Inc., 1790 Broadway, New York 19, N. Y.

The Food Industry

American Bottlers of Carbonated Beverages, Southern Bldg., Washington 5, D. C.

American Institute of Baking, 1135 W. Fullerton Ave., Chicago 14, Ill.

American Meat Institute, 59 E. Van Buren St., Chicago 5, Ill.

American Society of Refrigerating Engineers, 37 W. 39th St., New York 18, N. Y.

Bakery Equipment Manufacturers Association, c/o American Machine and Foundry Co., 551 Fifth Ave., New York 17, N. Y.

Biscuit and Cracker Manufacturers Association of America, 233 Broadway, New York 7, N. Y.

Food Research Institute, Stanford University, Palo Alto, Calif.

Manufacturing Chemists Association of the United States, 608 Woodward Bldg., Washington 5, D. C.

National Live Stock and Meat Board, 407 S. Dearborn St., Chicago 5, Ill.

National Poultry, Butter and Egg Association, 110 N. Franklin St., Chicago 6, Ill.

National Restaurant Association, 666 N. Lake Shore Drive, Chicago 11, Ill.

National Restaurant Institute, 2105 Broadway, New York 23, N. Y.

COMMERCIAL SUPPLY CATALOGS FOR THE MILK AND FOOD INDUSTRY*

Dairy Industries Catalog of Equipment, Supplies, and Services Used by Dairy Products Manufacturers. Edited and published annually by the Olsen Publishing Co., 5th and Cherry Sts., Milwaukee 12, Wisc.

* These list companies, manufacturers, and jobbers of supplies and equipment.

Food Industries Catalog and Directory: Equipment—Supplies—Materials. Published annually by Food Industries, McGraw-Hill, 330 W. 42nd St., New York 18, N. Y.

PARTIAL LIST OF COMPANIES PRODUCING OR HANDLING SULPHATED HIGHER ALCOHOLS (WETTING AGENTS*)

American Cyanamid and Chemical Corp., 30 Rockefeller Plaza, New York 20, N. Y.

Carbide and Carbon Chemicals Corp., 333 Hudson St., New York 13, N. Y.

Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J. (Trade name of wetting agent, Arctic Syntex M Beads)

E. I. du Pont de Nemours and Co., Inc., Organic Chemicals Dept., Wilmington, Del. (Trade name of wetting agent, M.P. 189)

J. B. Ford Co., Wyandotte, Mich. (Trade name of wetting agent, Neo Suds)

Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo.

National Aniline Division, Allied Chemical and Dye Corp., 40 Rector St., New York 6, N. Y.

Onyx Oil and Chemical Co., 15 Exchange Place, Jersey City, N. J.

MANUFACTURERS OF MILKING MACHINES

Ben H. Anderson Mfg. Co., Madison 4, Wisc.

Anderson Milker Co., Jamestown, N. Y.

Babson Brothers, Chicago 23, Ill.

Dairy Equipment Co., Lansing 11, Mich.

DeLaval Separator Co., 165 Broadway, New York 6, N. Y.

Hinman Milking Machine Co., Oneida, N. Y.

International Harvester Co., Chicago 1, Ill.

Lacta Separator Co., Chicago 13, Ill.

Perfection Milker Co., Minneapolis 13, Minn.

Pioneer Manufacturing Co., Milwaukee, Wisc.

Rite-Way Products Co., Chicago 13, Ill.

Universal Dairy Supply Corp., San Francisco 7, Calif.

MAJOR MANUFACTURERS OF DISHWASHING MACHINES

American Production Co., 690 Market St., San Francisco 4, Calif. (Surgex Dishwasher)

* Produced by catalytic hydrogenation of natural fats and oils in which fatty acids are reduced to corresponding fatty alcohols and these alcohols reacted with sulphuric acid, neutralized with caustic soda. These products are used in place of soap in many fields; work equally well in hard or soft water; called "soapless suds" because they do not lather and leave no scum when used with hard water. Used as a detergent in home and power laundries; as a wetting, penetrating, scouring, dispersing, and emulsifying agent in many industries, particularly in the textile, dry cleaning, paper, and leather fields; used extensively in hair shampoos, dairy cleaning powders, and dishwashing compounds.

Anstice and Co., Inc., Rochester 9, N. Y. (Sterling)
Blakeslee and Co., 19th St. & 52nd Ave., Cicero Station, Chicago 50, Ill.
Champion Dishwashing Machine Co., Erie, Pa.
Colt's Patent Fire Arms Mfg. Co., Autosan Division, Hartford 5, Conn. (Colt-Autosan)
Faspray Corporation, Red Bank, N. J.
Fearless Dishwasher Co., Inc., Rochester, N. Y.
Hobart Mfg. Co., Troy, Ohio
Insinger Machine Co., State and Robbins Ave., Philadelphia, Pa.
Jackson Dishwasher Co., 3703 E. 93rd St., Cleveland, Ohio
Lansing Mfg. Co., 1978 E. 69th St., Cleveland, Ohio. (The L-O Dishwasher)
Universal Washing Machinery Co., Nutley, N. J.

Appendix B

ESSENTIAL FIELD EQUIPMENT FOR THE FOOD SANITARIAN

To work effectively and carry on productive field investigations, the food sanitarian should have the following:

1. A maximum self-registering pocket-type thermometer with a range of 20° to 220° F. in two-degree divisions. An armor-clad thermometer six or eight inches in length is recommended.
2. A pocket thermometer for general temperature determinations, with a range of 20° to 120° F. (Catalogs issued by manufacturers of thermometers or companies selling laboratory equipment should be consulted for the type of thermometer desired. Special thermometers are available for a variety of uses, and a study of descriptive literature is recommended.)
3. A field kit for making determinations of available chlorine. Either a kit with color standards and orthotolidine as an indicator or a starch iodide test set may be used. Pocket-size kits are available. Consult catalogs as recommended in (2) above. Starch iodide test papers are obtainable for making rapid estimates of available chlorine, but where more accuracy is desired the test kit is recommended.
4. A light meter. A small pocket-size meter is available from certain manufacturers of electrical equipment.
5. A flashlight. A two-cell standard size flashlight will be found adequate.
6. A camera. A small fixed-focus camera with flashlight attachment is adequate for general use; the flash attachment permits the taking of interior views.
7. One ounce of creosote for denaturing.
8. One-quarter ounce of uranine dye for denaturing.
9. A supply of four-ounce metal screen cap bottles.
10. Ten medium-sized paper bags, one can opener, one meat trier, one butter trier, one box of gummed labels.
11. Ten swab bottles with wood, glass, or metal applicators attached to cap.
12. Ten squares of glossy white paper 8 by 10 inches; ten squares of dull black paper 8 by 10 inches.
13. One cyanide insect bottle.
14. Ten homeopathic vials, wrapped sterile spoons, and tongue blades.
15. A clip board for holding inspection forms.
16. Educational and instructive literature such as bulletins on food-handling methods, line drawings of food equipment and kitchen plans, copies of rules and regulations, and forms for issuing sanitary orders.

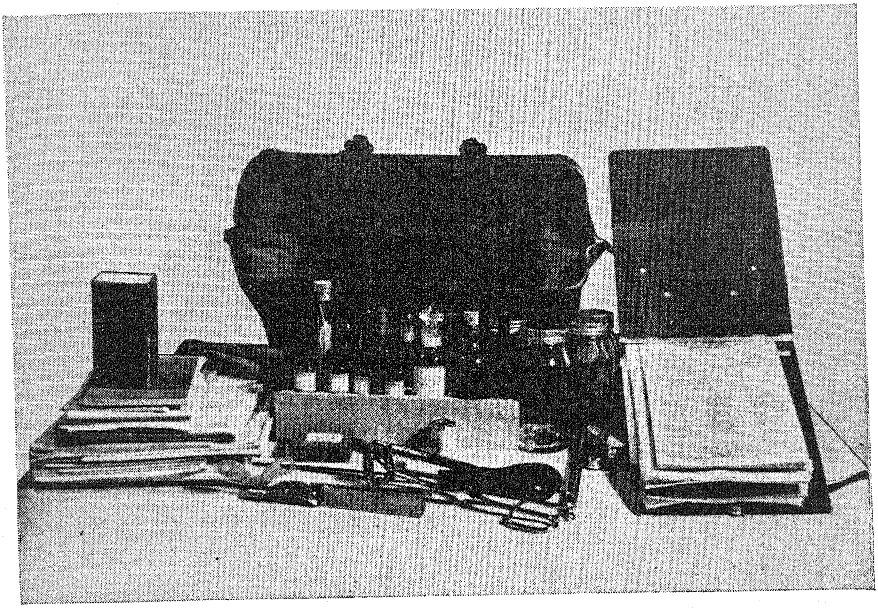
Appendix C

SPECIAL FIELD EQUIPMENT AND ANALYTICAL PROCEDURES

Food sanitarians in the Baltimore, Maryland, City Health Department carry special equipment on their rounds and are prepared to do certain screening tests in the field. Each inspector has a convenient leather case (see Figures 59 and 60) which contains the usual detention cards, violation notices, copies of laws, educational forms and leaflets, sample identification cards, and such conventional equipment as flashlight, thermometer, can opener, and meat trier. Paper bags and paper spoons are carried for collecting food samples, sterile four-ounce bottles for water samples, and sampling vials for food utensil swabbing. Portable apparatus is also provided for the detection of fluorides, cyanides, cadmium, arsenic, and sulphites; equipment is included for testing

Courtesy Baltimore City Health Dept.

Figure 59. Sanitarian's carrying case for holding supplies needed in the field



Courtesy Baltimore City Health Dept.

Figure 60. Contents of the sanitarian's carrying case

the strength of chlorine solutions used as disinfectants and for the detection of spoilage of shucked oysters and crab meat. Wherever possible, testing materials are contained in uniform glass vials and each case is fitted with a wooden rack to hold the apparatus. All solutions, test papers, and other equipment are periodically replaced and reconditioned by the Bureau of Laboratories.

Special procedures that may be carried out by the sanitarian are described below.*

DETECTION OF SPOILAGE OF SHUCKED OYSTERS

The pH of fresh shucked oysters varies between 6.0 and 7.0. A pH value of 5.4 to 5.8 is regarded with suspicion, while values below this range are indicative of decomposition. A convenient field examination is made by transferring 5 ml. of oyster liquor to a test tube graduated at 5 ml. and adding 0.5 ml. of methyl red indicator solution (0.02 per cent methyl red in 50 per cent alcohol). After mixing, the color produced is compared with the methyl red color standards in sealed glass ampules. Standards reading pH 5.4 and 6.0 are provided. If there are indications that the oysters have been recently washed, several drops of the indicator solution are placed directly on the oyster. The production of a persistent red color indicates spoilage.

* These are quoted in part, with bibliographical references, from Korff, Ferdinand A., and Kaplan, Emanuel, "Field Equipment for Food Inspectors," American Journal of Public Health, 32:1110–1116, October 1942.

DETECTION OF SPOILAGE OF CRAB MEAT

The decomposition of crab meat involves a progressive proteolysis, accompanied by a rapid rise in the ammonia content of the meat. In 1932, Harris[1] proposed the Nessler ammonia test as a means of differentiating fresh from spoiled crab meat. The test used by our inspectors is done in this manner: About 1 gm. of crab meat is transferred to a test tube and shaken with several ml. of water, and 2 to 3 drops of Nessler's reagent are then added. The immediate development of a deep yellow or brown color indicates spoilage of the meat. The test is used only as an aid to organoleptic examination of the suspected crab meat.

DETECTION OF CYANIDE IN METAL POLISH

The qualitative detection of cyanide in metal polishes in the field may be conveniently made with sodium picrate test papers.[2] This test paper is moistened with water and is then suspended in the container of the suspected polish. Care is taken that the paper does not come in contact with the material. The paper turns orange and then brick-red in five to ten minutes if the concentration of cyanide (asKCN) exceeds 0.5 per cent. Although the reaction is not wholly specific for cyanide, the method serves as a ready screening test in the field.

DETECTION OF CADMIUM PLATING ON UTENSILS

A simple testing unit was devised to detect cadmium during the inspection of food establishments in Baltimore.[3] The outfit consists of two small vials. One contains strips of filter paper which have been impregnated with a 20 per cent sodium sulphide solution and dried; the other contains small cotton swabs immersed in 10 per cent nitric acid. The swab is rubbed on the suspected metal and is then applied to the sodium sulphide paper which has been previously moistened with water. The instantaneous appearance of a canary-yellow stain on the paper indicates the presence of cadmium.

DETERMINATION OF AVAILABLE CHLORINE IN DISINFECTANT SOLUTIONS

The strength of chlorine rinse waters is determined by a modification of the orthotolidine test.[4] Inspectors carry a 2-ounce dropping bottle of orthotolidine solution, a 100-p.p.m. permanent chlorine standard in a sealed ampule, a test tube of the same diameter as the standard and graduated at 10 ml., and a medicine dropper calibrated to deliver 20 drops of water per ml. Ten ml. of tap water are added to the tube, followed by four drops (0.2 ml.) of the rinse water under test, and one ml. of the orthotolidine solution. After five to ten minutes, comparison is made with the standard. The permanent standard actually corresponds to 2 p.p.m. of chlorine. However, the sample is diluted 1 to 50 in the test. The permanent standards are prepared by the method of Scott, which permits color-matching irrespective of the tube length.

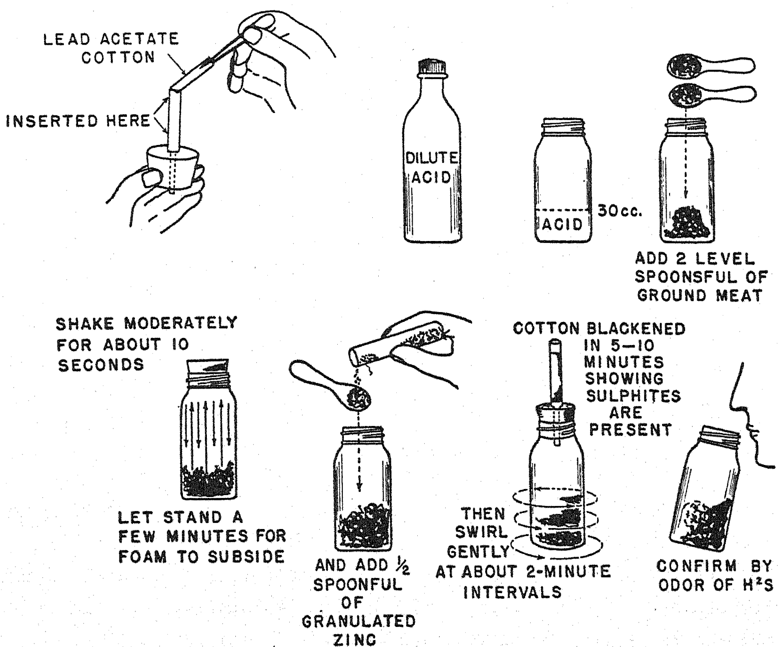
TESTING OF FLUORIDE-CONTAINING INSECTICIDE POWDERS

Inspectors are equipped with vials of fluoride test paper. The test depends on the fact that in the presence of strong acids soluble fluorides decolorize the zirconium lake of sodium alizarin sulphonate. Strips of filter paper are impregnated with the fluoride reagent[6] and are then dried. The test is made by moistening a test paper with diluted hydrochloric acid (the orthotolidine solution carried by the inspectors for the residual chlorine test may be used). The moist strip is then touched to the suspected powder and, in the presence of a large amount of soluble fluoride, decolorization of the paper will occur in about five seconds. Decolorization is evident in about 30 seconds when a 1 to 1,000 dilution of sodium fluoride powder in flour is used. A reaction time of five minutes should be allowed for traces of fluoride. Phosphates and oxalates may yield false tests and therefore positive findings should be confirmed in the laboratory.

DETECTION OF SULPHITES IN MEAT PRODUCTS

Sulphites in ground meat serve partly as a preservative but are employed chiefly to deodorize and to restore the bright red color of fresh meat.[7]

To make the test (see Figure 61), about 10 gm. of ground meat are trans-



Adapted from drawing in Korff and Kaplan, "Field Equipment for Food Inspectors," A.J.P.H., October 1942

Figure 61. Step-by-step field procedure for testing ground meat for presence of added sulphites

ferred to a wide-mouthed bottle containing 30 ml. of ten per cent sulphuric acid. The bottle is stoppered and shaken moderately for ten seconds. Several minutes are allowed for foam to subside. Three grams of 30-mesh granulated zinc (arsenic and sulphur free) are added. A stopper containing a Gutzeit scrubber tube previously fitted with a No. 2 cotton dental roll which has been impregnated with 20 per cent lead acetate solution is immediately inserted. The cotton roll will become black in five to ten minutes and after about ten minutes the bottle may be opened, when there will be a decided odor of hydrogen sulphide if sulphites are present. The test will detect as little as one grain of sodium sulphite in a pound of ground meat. Traces of sulphites in foods may yield false positive tests, and because of this the outfits are intended for screening tests only. All samples which show positive reactions are submitted to the laboratory for confirmatory analyses.

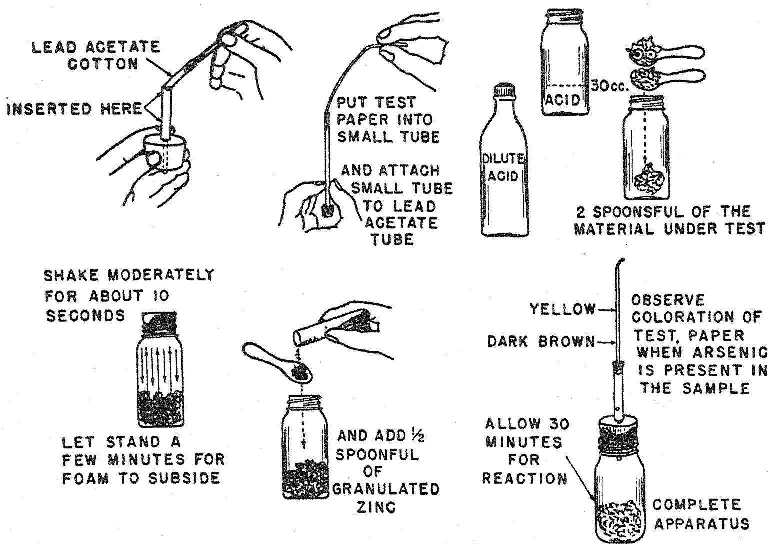
DETECTION OF ARSENIC SPRAY RESIDUE

The presence of excessive amounts of arsenic spray residue on fruits and vegetables is suspected when there are unusual deposits on the foods. In order to eliminate the detention of truck, boat, or railroad shipments pending laboratory examination, testing for arsenic is done in the field. The test generally used is an adaptation of the official Gutzeit method for arsenic of the Association of Official Agricultural Chemists;[8] similar modifications have been used by others.[9]

The equipment designed for the sulphite determination in ground meat is also used for the arsenic test. A piece of glass tubing is fitted to the Gutzeit scrubber tube to hold a strip of sensitized mercuric bromide paper. In addition, 15 ml. of 40 per cent stannous chloride solution are added to each liter of the 10 per cent sulphuric acid reagent. In practice the acid used for the sulphite test contains the stannous chloride addition and is thus also suitable for the arsenic examination. The details of the test are indicated in Figure 62. The directions are essentially the same as in the case of the sulphite examination. Scrapings of suspected material are introduced into the generator. The acid and zinc are added and the reaction is allowed to proceed for thirty minutes. A decided yellow to dark brown coloration of the sensitized mercuric bromide paper indicates the presence of arsenic.

1. Harris, M. M. A bacteriological study of decomposing crabs and crab meat. Am. J. Hyg., 15:260–275, January 1932.
2. Official and tentative methods of analysis of the Association of Official Agricultural Chemists. 5th ed. Washington, D. C., 1940, p. 366.
3. Baltimore Health News, 19:23, March 1942.
4. Standard methods for the examination of water and sewage. 8th ed. New York, American Public Health Association, 1936, p. 20.
5. Scott, R. D. Improved standards for the residual chlorine test. Water Works and Sewerage, 82:399, November 1935.

6. Snell, F. D., and Snell, C. T. Colorimetric methods of analysis. New York, D. Van Nostrand Co., Inc., 1936, p. 581.
7. Leach, A. E., and Winton, A. L. Food inspection and analysis. 4th ed. New York, John Wiley & Sons, Inc., 1920, p. 216.
8. *Ibid.*, p. 390.
9. Mayo, N., and Taylor, J. J. Enforcement of arsenical spray law, 1931–1932. Florida Quart. Bull., 42:12, 1933.



Adapted from drawing in Korff and Kaplan, "Field Equipment for Food Inspectors," A.J.P.H., October 1942

Figure 62. Field test for arsenic spray residue, showing apparatus and procedure

FOOD UTENSIL SWABBING

The collection of samples from drinking glasses, silverware, dishes, etc., for bacteriological examination is another procedure for which the food sanitarian should be equipped. Satisfactory containers consist of screw-cap swab bottles 23 by 70 mm., or bacteriological test tubes 15 by 100 mm. with cork or rubber stoppers. Cotton plugs are not satisfactory. A stiff wire or glass applicator attached to the bottle cap with a firmly twisted cotton swab on the end may be used. The swab bottles contain a buffered distilled water solution. (For preparing this solution see Standard Methods for the Examination of Dairy Products, 8th ed., New York, American Public Health Association, 1941, p. 126; also Public Health Bulletin 280, Ordinance and Code Regulating Eating and Drinking Establishments, U. S. Public Health Service, Washington, D. C., 1943.)

The properly prepared solution is then distributed in the swab containers

in amounts that will provide, after autoclaving for thirty minutes, exactly one ml. for each utensil examined per swab; e.g., 4 ml. for four utensils, 5 ml. for five utensils, etc.

*Collecting samples.** Utensils to be examined shall include at least glasses, cups, and spoons, if used, and at least 4 of each shall be selected at random from the shelves upon which clean utensils are stored. If a direct check of the dishwashing methods is desired, utensils should be selected from those recently washed. Care shall be taken to prevent contamination by handling.

Use 1 swab for each group of 4 or more similar utensils. Take the swab from a freshly opened container of dilution water, and squeeze it against the side of the container so as to remove excess water, leaving the swab moist but not wet. Rub the swab slowly and firmly three times over the significant surfaces of 4 or more similar utensils. After swabbing each utensil, return the swab to the container of dilution water, rotate the swab in the dilution water, and press out the excess water against the side of the container before swabbing the next of the 4 or more utensils in the group.

The significant surfaces of utensils consist of the upper one-half inch of the inner and outer rims of cups and glasses and the entire inner and outer surfaces of the bowls of spoons. If it is desired to examine forks and surfaces of dishes, etc., the area to be swabbed should include the entire inner and outer surfaces of the tines of forks, and the inner surfaces of plates and bowls over an area of 4 square inches that would come in contact with the food. The area to be swabbed on plates and bowls may be delineated by using the flexible metal frame, which must be sterilized immediately before use. Flaming or burning off with alcohol constitutes satisfactory sterilization for this purpose.

After completing the swabbing of all utensils in the group of 4 or more, replace the swab in the container of dilution water. Use a new swab container for the next group of utensils. Keep the containers iced while in transit to the laboratory, and plate the dilution water samples as soon as possible, preferably within 4 hours of swabbing.

* Quoted from United States Public Health Service. Ordinance and code regulating eating and drinking establishments recommended by the United States Public Health Service. Washington, Government Printing Office, Public Health Bulletin No. 280, 1943, p. 34.

APPENDIX D

PHYSICAL EXAMINATION FOR SIGNS OF FOOD SPOILAGE

POULTRY

Dressed poultry decomposition can be detected by a stickiness under the wings, under the thigh, at the tip of the wings, and around the apron. There is a sebaceous gland at this latter portion that is often cut out by the dresser because of its quick spoilage-detecting property.

SEAFOOD

Fresh fish is very perishable. The condition of raw fish can be judged by noting certain points. The gills should be pink to dark red in color and firm; their odor should be not unpleasant but one which might be described as "marine"; as decomposition takes place the gills become faded until in putrid fish they become gray or grayish green, and slimy. In fresh fish the eyes are bright, clear, and not sunken in the head; as decomposition progresses the eye becomes dull and sunken. In three to four days the eyes become gray and shrunken. When decomposed blood cells diffuse into the meat, causing the flesh around the backbone to assume a reddish color, the flesh is not strictly fresh. The intensity of this discoloration may be used to judge the length of time since the fish was caught.

Spoilage of shrimp can be detected when the flesh becomes soft and when pink areas appear on the shell; in fresh shrimp the shell is gray.

Spoilage of soft-shell crabs can be detected when the gills or "deadmen" are mushy, when the shell pulls away from the body, and when the odor is abnormal.

EGGS

Egg spoilage can be detected by candling. Directions for candling will be found in the United States Department of Agriculture Farmer's Bulletin No. 1378 entitled "Marketing Eggs."

MEAT

Consult "Textbook of Meat Hygiene" by Edelmann, Mohler, and Eichhorn, Philadelphia, Lea and Febiger, 8th ed., 1943. See also Regulations Governing Meat Inspection of the United States Department of Agriculture, known as B.A.I. (Bureau of Animal Industry) Regulations, B.A.I. Order 211, Revised; and "Microbiology of Meats" by L. B. Jensen, Champaign, Ill., Garrard Press, 2d ed., 1945.

Appendix E

FOOD POISONINGS AND INFECTIONS

One of the chief duties of the food sanitarian is to promote wholesome conditions within the food industry so that food-borne outbreaks can be averted. To do this the sanitarian must know the causes of food poisonings and infections and learn to recognize signs that may be conducive to their occurrence. Table IX is designed to assist him in this connection.

INVESTIGATING FOOD-POISONING OUTBREAKS

Determining the cause of outbreaks of food poisoning is frequently a challenge to the food sanitarian. If he is to be successful in his investigation, he must follow a carefully laid out procedure. The following material, quoted from "Food Poisoning" by G. M. Dack (Chicago, University of Chicago Press, 1943, pp. 2–7) should be of assistance:

> *Investigation of Food-Poisoning Outbreaks*
>
> Small outbreaks of gastrointestinal upsets occurring in the family are usually not reported. In general, no recognition is given the event, and the family physician is seldom summoned. When a number of people are affected, however, particularly when they have attended a banquet or recently eaten at the same public eating establishment, considerable attention is given the episode by health authorities and the press. Illnesses in small family groups due to the fatal type of food poisoning known as "botulism" are usually reported, but this type of food poisoning is relatively uncommon.
>
> Such small family outbreaks as do become known are usually brought to light through complaints made by a member of the family to the grocer or butcher regarding a suspected item of food. In the majority of cases the complaint is carried no farther, but reports are sometimes made by the retailer to the manufacturer or producer, and these, in most instances, are investigated. Much time often elapses between the illness and the investigation, thus making it difficult or impossible to determine the causative agent. Frequently meat is suspected by the family as the cause, since it conforms with the false "ptomaine" notion of food poisoning. Very often upon investigation the food item alleged by a member of a family to be responsible for an outbreak is exonerated, and some other item of food or other cause is found.
>
> One of the distinctive characteristics of an outbreak of food poisoning is the sudden illness of several individuals following a specific meal and usually ascribed to a definite item of food served at that meal. Often only one person in such a group develops gastrointestinal symptoms. Some of

these single illness cases are actually brought to court for trial. The alleged symptoms are one or more of the following: nausea, vomiting, diarrhea, and abdominal cramping. Careful study of such individuals often reveals one of a large variety of other illnesses to which these symptoms can be attributed. Such illnesses are coronary heart disease, gall-bladder disease, passage of renal calculi, appendicitis, brain tumors, certain forms of intestinal allergy, cerebral hemorrhage, onset

TABLE IX. Causes of food poisoning and infections*

Causative agents	Foods often implicated	Usual time of onset
OF BACTERIAL ORIGIN		
Clostridium botulinum toxins	Improperly processed canned and bottled food	12 to 24 hours
Staphylococcus enterotoxin	Custard pastries, cooked ham, hollandaise sauce, sliced cooked meats	3 to 6 hours
Salmonella infections	Sliced cooked meats, meat and poultry salads, "warmed over" foods, custard-filled pastries	6 to 18 hours
Enteric infection:		
Typhoid fever	Oysters, raw milk, other dairy products	3 to 38 days
Bacillary dysentery	Salads, "warmed over" foods, milk, and other dairy products	1 to 7 days
Tularemia	Wild rabbits (by handling)	1 to 10 days
OF NON-BACTERIAL ORIGIN		
Inorganic chemicals: Arsenic, Lead Fluorides Antimony Cyanides Cadmium, Zinc Copper, Barium Others	Any food accidentally contaminated	Several minutes to hours, depending upon dosage
Poisonous animals and plants	Rhubarb leaves, mussels in certain seasons, poisonous mushrooms, poisonous fish	Variable
Animal parasites	Trichinella in pork Diphyllobothrium in some fish Taenia in beef	Several days to weeks
Allergies and environmental circumstances	Specific foods consumed by persons allergic to these foods Consuming food while exposed to dangerous gases (CO), high temperatures, etc.	Immediate to several hours

* From Korff, Ferdinand A. Food establishment sanitation in a municipality. American Journal of Public Health, 32:739–744, July 1942.

of infectious diseases, and functional bowel distress associated with emotional upsets.

It is important when an outbreak of food poisoning occurs that it be immediately investigated if the true cause is to be established. A delay of hours after vomiting and diarrhea have occurred may mean that chemical poisons have been discarded in the vomitus and excreta. If none of the original food is left, it may be difficult to identify the specific agent. In food poisoning of bacterial origin, a delay of hours may often bring about marked bacterial changes in a perishable product which were not present at the time of consumption. From a legal standpoint, a prompt and intelligent investigation may prevent unnecessary litigation expense and afford the basis of a just settlement if settlement appears warranted. It is generally important to ascertain in so far as possible what items of food had been eaten at previous meals for a period of forty-eight hours. When a large number of cases occurs within as short a period as two to three hours after partaking of food, attention should be centered particularly on the last meal and on any food eaten by all or a majority of the persons afflicted. When the onset of symptoms in different individuals appears over a period of many hours, it is important to know the items of food in the diet for several meals past. If the outbreak involves persons who have shared in a particular meal or eaten at a particular place, it is a good plan to prepare a list of the various items of food served and check these items with persons who ate the meal or who ate at the place in question. Frequently a single item may be found to be the common denominator for those who are made ill. If this fact is observed, much time may be saved by making a laboratory examination directly on the incriminated item of food. Usually not every individual will be made ill when a specific item is involved. Such variables as the amount eaten (dosage) and individual resistance play an important part. Generally, however, the majority of people partaking of the involved food will be affected when such an outbreak occurs. Sometimes psychic disturbances account for symptoms in some individuals who are present during the illness of others but who have not eaten the incriminated food. If too long a time elapses before the investigation is started, the data obtained are less reliable, since most people find it difficult to remember what they have eaten at previous meals or whether they experienced any symptoms at the time in question. An excellent questionnaire [given here in condensed form] has been prepared by individuals concerned with the investigation of food-poisoning outbreaks.

Form 1: Questions for Persons Alleging Illness from Food

1. What is the name? Age? 2. Address? 3. Are you employed in any business and, if so, by whom? 4. Married or single? 5. How long after eating were you made ill? 6. Were others made ill? If so, who? (Age

of each.) 7. Did any person eat the same foods without becoming ill? 8. If so, who? (Names and addresses.) 9. What were the first symptoms of your illness and when did they occur? 10. Was there pain in the stomach or abdomen? 11. Was there vomiting? For how long? 12. Was there diarrhea or constipation? 13. Please tell anything else you remember about your illness and the events leading up to it. 14. How long did the acute illness last? 15. Please itemize expenses, if any, resulting from your illness. 16. What is name and address of the doctor who attended you during your illness? 17. Is he your regular doctor? If not, who is? 18. When were you last attended by a doctor before this illness and for what cause? 19. Have you ever undergone an operation and, if so, for what? 20. Have you had stomach or digestive trouble in the past? 21. If so, of what nature? 22. To what did the doctor attribute the illness? 23. Do you attribute the illness to the eating of any particular food? 24. If so, what food? 25. Why? 26. What foods did you eat at the suspected meal? 27. What was eaten at the four meals preceding the suspected meal? (All foods eaten at each meal, if possible, and also between meals.) 28. What foods, if any, did you eat between the suspected meal and the onset of your illness? 29. Did the doctor take the container or any of the suspected food left after the meal? 30. Did you feed any of the suspected food to dogs, chickens, or other animals? If so, were they made sick? 31. Have you the container or any portion of the foods which you believe caused the illness? 32. If not, what was done with them? 33. From whom was food purchased and by whom? 34. Date of purchase. 35. Give name of brand and of manufacturer or distributor on label. 36. Did you ask for that particular brand? 37. Are you accustomed to buying that particular brand? 38. Where was the food left before using? 39. Where was the food kept after unwrapping or opening? 40. State as exactly as possible how the food was prepared and served. 41. Did the appearance or odor indicate anything unusual in the food on unwrapping or opening? If so, please give particulars. 42. On what date and at what meal was the food eaten? 43. At the time of eating the food, did you notice any peculiarity in the appearance, taste, or odor of it? If so, please describe.

Witness: ____________________ ________________________

Date: ____________________ [*Signature*]

Form 2: Questions for the Attending Physician in Case of Alleged Illness

1. Name and address of physician. 2. Name of patient. 3. On what date or dates did you treat this patient? 4. How long had the patient

been ill when you arrived? 5. Was the onset of the disease sudden or had there been previous illness? 6. How many persons were ill of the same type of disease and under your observation? 7. What were the general symptoms (appearance of patient, continuous or spasmodic pains, nervous, excited, or in coma, vomiting, or diarrhea)? 8. What was the pulse rate? 9. Regular or intermittent? 10. Pulse tension? 11. Was the temperature persistently above or below normal? 12. What was the highest and lowest point reached? 13. Was a temperature and pulse record kept? 14. What was the number of respirations per minute and character? 15. Was there any disturbance of vision? 16. What disturbance of the reflexes, if any, was noted? 17. How long did the attack continue? 18. General remarks. 19. Was any bacteriological or chemical examination made of the blood, vomitus, or excreta? 20. What was your diagnosis? 21. If food poisoning, what food do you believe caused the illness? 22. Was a laboratory examination made of any suspected food? 23. If so, what was found? 24. What treatment was followed or prescribed? 25. Was any morphine or opiate used to alleviate pain? 26. Was any strychnine or other stimulant used? 27. Do you consider recovery complete? 28. Have you a detailed record of the case? 29. Have you attended this patient before? If so, for what ailment?

In case of death: 30. Was an autopsy performed or any post-mortem specimens examined? 31. If so, by whom was such autopsy or examination made?

Witness: ____________________ ____________________

Date: ____________________194__ [*Signature*]

When the investigator has obtained the necessary information, it is generally possible to get some clue as to the nature of the agent involved so that treatment of the patient may be immediately instituted. Furthermore, if a specific agent is suspected, much time is saved in the laboratory tests. The problem of determining whether the agent is chemical, plant, or animal poison, intoxication with bacterial products, or a food-borne infection is often difficult. The solution of this problem is simplified by a careful field investigation.

REHEATING OR "PASTEURIZING" CUSTARD-FILLED PASTRIES

Staphylococcic outbreaks of food poisoning have frequently been traced to custard-filled pastries such as cream puffs, éclairs, and Boston cream pies. Certain precautions should be followed in the preparation of these pastries. Instructions issued in bulletin form by the Baltimore City Health Department are quoted herewith, as they serve as an excellent guide for bakers, res-

taurants, and hotels. The material in the bulletin was based on studies by Stritar, Dack, and Jungewaelter, *Food Research,* May–June 1936.

The Baltimore City Health Department urges bakers, pastry cooks and chefs to "pasteurize" or rebake all custard-filled pastries because:

1. This process destroys the bacteria or germs that may cause food poisoning.
2. It gives assurance that a precaution has been taken to prevent illness which may result from this type of bakery product.
3. The souring of the custard within the pastry is delayed often for several days.

The rebaking process, briefly, consists of placing the finished pastry, after the custard has been filled into the shell or on the layers, into a hot oven at 425 to 450 degrees Fahrenheit for about twenty or twenty-five minutes or until the custard reaches 180 degrees Fahrenheit. The following methods are recommended:

Éclairs and Cream Puffs

1. Bake the shells and prepare the custard.
2. Fill the pastry shells with the custard as soon as the custard has jelled, which should be not more than one-half hour after it has been taken from the fire or double boiler.
3. Place the filled éclairs or cream puffs on an icing grate. Place this icing grate in a shallow bun pan, cover the bun pan with a deep pan and the entire equipment is then placed into the oven at 425–450 degrees Fahrenheit.
4. Allow the filled pastry to remain in the oven until the temperature of the custard reaches 180 degrees Fahrenheit. The exact time depends upon the temperature of the oven, the type of oven, whether hearth or rotary, and where the pans have been placed in the oven.
5. After the filled pastry has been reheated so that the custard within the shell is 180 degrees Fahrenheit, remove the pans from the oven and allow the éclairs or cream puffs to cool on the grate out of the pan.
6. Icing may be placed on the finished product after it has cooled.

Boston Cream Pies or Custard Cakes

1. Bake the cake layers and prepare the custard.
2. As soon as the custard has jelled and within one-half hour after it has been taken from the fire or double boiler, spread the custard on one layer of cake.
3. Place the custard-spread layers on the icing grate and rebake the same as for cream puffs and éclairs until the custard reaches 180 degrees Fahrenheit.

4. Remove the pans from the oven and immediately put the upper layer of cake on the rebaked layer. Allow the finished cake to cool on the grate out of the pan.
5. Icing may be placed on the finished product after it has cooled.

Napoleons

1. Bake the napoleon layers and prepare the custard.
2. As soon as the custard has jelled spread the custard on one layer of the pastry, place the top layer on the custard and then slice into the desired number of sections.
3. Place the sliced sections on the icing grate and rebake them the same as for éclairs, cream puffs and cream pies or custard cakes, until the custard reaches 180 degrees Fahrenheit.
4. Remove the pan from the oven and allow the sliced sections to cool on the grate out of the pan.
5. Icing may be placed on the finished product after it has cooled.

Custard-Filled Doughnuts

Fill the custard into the doughnuts in the same manner as for éclairs or cream puffs and likewise rebake or "pasteurize" the custard-filled doughnuts the same as for éclairs or cream puffs.

As an alternate procedure to the rebaking of custard-filled doughnuts, filling the doughnuts with the hot, recently-made custard is suggested. In this method the custard should be filled into the doughnuts immediately after the custard is made and while it is still at a temperature of 180 degrees Fahrenheit or more. Be sure that the custard is at a temperature of 180 degrees Fahrenheit or more.

It is also suggested that marshmallow or jelly be substituted for custard in this type of pastry.

Appendix F

COURSES FOR THE INSTRUCTION OF FOOD HANDLERS

Chapter XIII was devoted to a discussion of plans and methods for organizing and conducting classes of instruction for food handlers. The following information, including a suggested course, is presented to supplement the material given there.

The amount of material that can be included in a course will obviously depend upon how many class periods are to be held, and their length. In a Texas program six two-hour sessions were held and the following topics covered:

Bacteriology. History, nature, growth, reproduction; shapes and groupings; common diseases of man caused by bacteria

Communicable Diseases. Relation of bacteria to disease; methods of disease transmittal; causes of decay and fermentation

Medical Zoology. Spread of disease by insects and animals; life cycles and habits; how they spread disease and contaminate and destroy food

Foods. Food spoilage, refrigeration, and preservation; relation of microorganisms and animal life; food poisoning and infection and resulting illnesses

Disinfection and Sterilization. Effects of chemical agents on bacteria; sanitization of utensils and equipment

Personal Hygiene and Sanitation. Hand-washing, rest-room sanitation, health certificates, blood tests, uniforms, personal appearance, use of side towel

In Flint, Michigan, four one-hour class periods are conducted covering these subjects:

Public Enemies. Elementary facts are given about bacteria, how they cause disease, and how communicable disease is transmitted. Bacteria are shown to be both helpful and harmful. The transmission of disease spread by infected food is emphasized.

Good Housekeeping. Particular emphasis is placed upon the importance of approved dishwashing and sanitizing methods as a means of preventing the spread of saliva-borne disease. Equipment and methods needed to obtain satisfactory results are discussed and certain essential apparatus is demonstrated.

Protecting Food. Refrigeration, storage, and display of foods to preserve and protect them from contamination are discussed at this lecture. Considerable attention is directed to common food contaminants such as insects, rodents, human droplet material, chemicals, and liquid wastes.

Points directing the food handler to store, protect, and display foods carefully form the main theme of this lecture.

The Individual. Personal cleanliness, hand cleanliness, correct uniforms, use of toilet and washrooms, and habits and practices which relate directly to the safety of food and drink are features included in this session.

These four lectures, supplemented by the use of appropriate slides, charts, demonstration material, and motion pictures, cover most of the essentials in food sanitation and should give the food worker a reasonably comprehensive appreciation of his responsibilities. While the exact amount and kind of material to be included in each lecture are of course best left to the judgment of the person conducting the course, the following outlines serve to demonstrate the general content of the course material given at Flint, Michigan.

Lecture 1: Public Enemies

A. In a study of public enemies, in this case bacteria which cause communicable disease, some understanding of their nature is extremely valuable for a broader appreciation of sanitary precautions which must be followed in the handling of food.
   1. Bacteria are everywhere
      a. They are invisible; in size they measure about 1/25,000 of an inch.
      b. Bacteria are both helpful and harmful to man. The harmful types are known as *pathogens* because they cause disease. The helpful bacteria serve man in the manufacture of such products as cheese, buttermilk, alcohol, vinegar, sauerkraut, etc. If bacteria were not present our earth would be covered with waste and refuse of all kinds.
      c. Bacteria serve a useful purpose in the field of sanitation since their presence or absence is a measure of sanitary quality. Bacteria are used to determine the safety of water, the sanitary quality of milk and oysters, the efficiency of dishwashing, etc.

B. Bacteria occur in different shapes and groupings.
   1. Oval or globular cells
      a. Single cells—the cocci
      b. Two cells—the diplococci
      c. Chains of cells—the streptococci
      d. Irregular clusters—the staphylococci
   2. Rod-shaped cells—bacilli
      a. Single cells
      b. Chains of cells
   3. Spiral cells—thread-like—spirilla
   4. Viruses—so small that they cannot be seen under an ordinary microscope—will pass through porcelain material similar to that used in automobile spark plugs

C. To live, bacteria must have conditions suitable to them.
  1. Conditions necessary for their growth are food, moisture, and temperature
    a. Food—If bacteria do not have food they soon die, except for some who may change to a resting or spore stage.
    b. Moisture—Like all living things, moisture is necessary to the life of bacteria. Man makes use of this fact when foods are preserved by drying and dehydration. (Name a few dried foods.)
    c. Temperature—There are temperatures which are favorable and unfavorable to bacteria. The effect of temperature on bacteria is applied to food preservation by keeping it cold (refrigeration) and by cooking it at high temperatures (canning). Many bacteria grow best at human body temperature.
    d. Other conditions—Air, light, pressure, chemicals, etc.

D. In relation to food handling, our main interest is to control bacteria so that disease is not spread in food establishments.
  1. The U. S. Public Health Service lists sixty-two communicable diseases. Twenty-five, or 40 per cent, can be transmitted in food-handling establishments.
    a. Some of the diseases that may be transmitted through faulty food-handling methods are: common colds, trench mouth, strep throat, pneumonia, scarlet fever, typhoid fever, and dysentery.
  2. Bacteria multiply rapidly under favorable conditions
    a. They reproduce by dividing in two. When conditions are favorable they divide about every 20 to 30 minutes.

E. An elementary understanding of bacteria as given in this discussion should result in a fuller appreciation of the "why" of sanitary procedures necessary to proper operation of a food establishment.
  1. The following sanitary precautions are important factors in the control of disease bacteria:
    a. Protection of food—To protect food from bacteria that may get on or in it and cause respiratory diseases, food must be kept properly covered
    b. Prohibiting use of common articles by employees, such as common cloth towels, toilet articles, and common cups or glasses
    c. Providing adequate hand-washing arrangements for food handlers to use and insisting that they be used
    d. Using pasteurized milk and dairy products
    e. Using a safe water supply and plumbing that is correctly installed to prevent back siphonage
    f. Proper cooking of meat, particularly pork, to kill the Trichinella worm. Proper refrigeration of perishable foods
    g. Proper washing and sanitizing of dishes and eating utensils to prevent the transmission of saliva-borne diseases

h. Other sanitary procedures similar to those mentioned are designed to promote sanitation and prevent bacterial contamination

F. Slides to show types of bacteria that cause disease are shown with this lecture. (A. S. Aloe Company, 1819–23 Olive, St. Louis, Mo., can supply a bacteriological chart from which pictures may be taken for these slides.)

1. The bacteria shown in the first group are those associated with respiratory diseases, e.g., those involving the mouth, nose, throat, and lungs.*
   a. Long chain streptococci
   b. Vincent's angina organisms
   c. Mouth of patient with Vincent's angina
   d. Tubercle bacilli
   e. Patient having chest x-ray
2. The next group are those spread by discharges of the bowel and bladder.
   a. Chart to show common channel of distribution of typhoid, bacillary dysentery and other diseases of intestinal origin. (An excellent chart suitable for this purpose can be found in Dunham's "Military Preventive Medicine," 3d ed., Military Service Publishing Co., Harrisburg, Pa., 1940, p. 155.)
   b. Typhoid organisms
   c. Amoebic dysentery (protozoa)
3. Food poisoning
   a. Staphylococci
   b. Group of foods frequently involved
   c. Food handler with bandaged finger working with food
4. Venereal disease
   a. Gonorrhea (gonococci)
   b. Microscopic examination of smear being made by bacteriologist
   c. Syphilis organism
   d. Taking a blood specimen

   The venereal diseases have been over-emphasized in relation to food handling. Their transmission is mainly by direct sexual contact. However, the venereal diseases present a very significant public health problem, and one of utmost importance in relation to individual and community health. (Present a brief discussion of syphilis and describe treatment required.)

G. The chief duty of every food handler is to prepare and serve wholesome food to his patrons in the most careful and sanitary manner.

1. In the light of facts presented in this lecture it should be appreciated that the fight against these invisible public enemies must continue on all fronts and be an unrelenting battle for cleanliness. Disease traced to

* In this group are 2-by-2 Kodachrome slides. While slides in color are probably more appealing, ordinary black and white slides can be profitably used.

carelessness in any food establishment causes untold suffering among those involved and economic loss to the business itself.

(To supplement this lecture the 16-mm. silent film "Man vs. Microbe," available through the Metropolitan Life Insurance Company, New York, may be shown. Also, the sound slide film "Germs Take Pot Luck," produced by the U. S. Public Health Service, is excellent for this lecture.)

Lecture 2: Good Housekeeping

A. Good housekeeping is a broad term applicable to the many and varied procedures that are carried out to maintain a food establishment in a clean and sanitary condition. From the standpoint of communicable disease control, that portion of good housekeeping which deals with the washing and sanitizing of dishes, food containers, and eating utensils is of particular importance and the major part of this discussion will be devoted to it.
  1. Public health reasons for proper sanitizing procedures
     a. Historical—Legislation by the State of Kansas in the early 1900's prohibiting use of common drinking cups. Use of paper cups on common carriers now required.
     b. Diseases of respiratory origin such as common colds, trench mouth, strep throat, and measles can be transmitted from person to person by unclean eating utensils.
     c. Army experience has demonstrated less influenza among troops when mess-kit sanitizing is properly done (Camp Tanforan, Calif., 1917).
     d. Glass sanitizing is a real problem. Repeal of prohibition, increase in soft drink business, and popularity of bars, lunch counters, and soda fountains add to the problem. Glass washing may be hurriedly and poorly done during rush hours.
     e. Tests have revealed counts as high as 100,000 bacteria per rim from glasses supposedly clean.
     f. Complaints by the public about dirty dishes and lipstick on glasses must be heeded.
  2. Equipment necessary to give desired results
     a. Safe and abundant supply of running hot and cold water (discuss briefly protection of water supply)
     b. Sinks, vats, or mechanical dishwashing machine
     c. Hot water heating facilities
     d. Cleaning compounds and detergents
     e. Cabinets or cupboards for clean dish storage
  3. Methods necessary to give desired results
     a. The washing procedure must be carefully done
        (1) Scrape dishes
        (2) Pre-rinsing is desirable and recommended
        (3) Hand dishwashing to be done in water as warm as can be borne

by operator (110°–120° F.); mechanical washing temperatures 120°–140° F.

(4) Washer arms, jets, spray nozzles to be kept clean. Frequent inspection needed. Booster heater under wash water tank to be used. Add detergent frequently during operation.

(5) Dish racks for mechanical washers not to be overloaded. Entire dish surface must be washed.

4. Sanitization of all dishes, food containers, and eating utensils. (If advisable, read section from local food ordinance dealing with dishwashing and sanitizing.)

   a. Sanitization signifies the destruction of disease germs and all others indicative of contamination

      (1) Scalding hot water—170° F. or above—a most satisfactory sanitizing agent

      (2) Hypochlorites (chlorine compounds) when correctly used give satisfactory results. Explain proper use

      (3) Quaternary ammonium chlorides. Explain proper use

      (4) Water temperature, disinfectant strength, and time of exposure are important factors to effect sanitization

      (5) Toweling of dishes not recommended, but if done, towels must be clean and used for no other purpose

      (6) Clean dishes to be carefully handled. Invert glasses, separate and protect silverware, keep fingers out of clean bowls, cups and glasses, handle silverware by handles

      (7) Single-service paper cups, plates, and wooden spoons are approved and recommended

Dishwashing and utensil cleaning are important procedures in the conduct of any public food establishment. Good housekeeping practices are essential. All possible means must be employed to prevent the spread of disease likely to result from faulty dishwashing and sanitizing methods.

B. Demonstration material arranged on a table at the front of the room is used in connection with this lecture. As the different steps relating to dishwashing are explained, certain points are demonstrated. In a discussion of dish sanitizing by immersion in scalding water, the use of the dipping basket, for example, is explained. The following articles are used as a supplement to the discussion: sample cans of cleaning compounds, samples of liquid and powdered bactericides, brushes, dish-dipping basket, dish rack for mechanical washers, metal glass storage rack, plates, glasses, silverware, and paper containers.

C. Slides, too, are used to illustrate points relating to essential equipment and methods. The following 2-by-2 Kodachrome slides are used:

   1. Operator using dish-dipping basket
   2. Glass-washing sinks with brushes, suitable for use in beverage places

3. Exterior view of dishwashing machine, showing wash and rinse water temperature gauges
4. Interior view of mechanical washer, showing clean jets and nozzles
5. Proper arrangement of dishes in rack about to be placed in washer
6. Large insulated hot water storage tank
7. Dust-tight dish storage cupboard
8. Waitress handling clean glasses correctly
9. Waitress handling silver (spoons) by handles
10. Storage of coffee cups in an inverted position.

(With this lecture " 'Twixt the Cup and the Lip," a 16-mm. sound film produced by the New York State Department of Health, may be used; or the U. S. Public Health Service's sound slide film "In Hot Water"; or "Dishwashing Dividends," a production of Economics Laboratories, St. Paul, Minn.)

Lecture 3: Protecting Food

A. The protection of food from contamination must receive consideration by all persons engaged in the food business. Keeping good food good is a real responsibility in every well-operated food establishment.

1. Food protection means control of certain conditions within the establishment itself

   a. Historical—Formerly, twenty or thirty years ago, foods did not receive the protection we take for granted today. In the country store stood the open cracker barrel, milk was dipped and sold raw, foods were sold in bulk form, merchandise was promiscuously displayed without protection. Now we understand the dangers of these practices and take steps to prohibit them. Open displays subject food to several types of contamination.

   b. Human droplet infection, the mucous material from the mouth and nose when one sneezes or coughs—such material sprayed over food is highly dangerous.

   c. Insects, including the fly and cockroach—the fly breeds in filth, thrives on all types of refuse, and carries harmful germs to food. The fly's habits and structure are such that he is a constant menace and must be controlled. (Further discussion of the fly, with control measures, can be interjected here if desired.) The cockroach has to be combatted in nearly all places where food is handled. Roaches crawl over food, soiling and ruining it. (Control measures, habits of the roach, and other facts pertinent to this insect may be pointed out in more detail.)

   d. Rats and mice—mice not as serious a problem as rats, mainly because they are relatively easy to trap. The rat, moreover, is more difficult to control, is a spreader of disease and an economic liability.

Through food which he contaminates he can spread typhoid, dysentery, food-borne infections, and infectious jaundice.

e. Poisonous chemicals—roach powder containing sodium fluoride should be colored to distinguish it from other powders. Sodium cyanide in silver polish is not permitted. Cadmium used in plating cans may be included in the list of poisonous chemicals.

2. Food protection also involves refrigeration of perishables
   a. Modern refrigeration has contributed much to the safety of our food supply
      (1) Perishables like meat, fish, poultry, and dairy products must be held at 50° F. or below
3. Foods must be carefully handled to prevent contamination by employees
   a. To eliminate direct hand contact, in so far as possible, utensils such as scoops, tongs, butter forks, cream and sugar dispensers must be used. Pasteurized milk must be served from half-pint bottles.

B. For the second portion of this lecture slides are used to show some of the means that can be employed to afford protection to food. Slides shown are 2-by-2 Kodachrome, as follows:
   1. A glass-enclosed meat display case
   2. Transparent covered case for fried cakes
   3. Cookies in glass-topped boxes
   4. Covered cream dispenser
   5. Glass-enclosed pastry case
   6. Handling baked goods with tongs
   7. Serving candy with scoop
   8. Serving crackers in waxed paper envelopes
   9. Using sugar dispenser
   10. Using butter fork for butter pats
   11. Serving customer with milk from half-pint bottle
   12. Serving ice cream with clean scoop taken from dipper vat
   13. Interior view of neatly arranged refrigerator
   14. Elevated food display
   15. Proper garbage and waste disposal.

(Two films are used with this lecture: the first is a 16-mm. film—there is a sound version and a silent version—entitled "The Fly," produced by Erpi Films, 1841 Broadway, New York 19, N. Y.; the second, entitled "Keep 'Em Out," deals with rat control and is distributed by Stark Films, Howard and Centre Streets, Baltimore, Md.)

Lecture 4: The Individual

A. Of particular importance to the safe and sanitary handling of food are the health and personal habits of the food handler.

1. The term "personal hygiene" as used in this discussion means an application of rules and laws governing personal health. Individual habits and practices are very important in the food business.
   a. There is a direct relationship between personal habits and practices and the contamination of food.
   b. Cleanliness of person with regard to both body and clothing is significant. The odor of perspiration is offensive but can be controlled by regular bathing and the use of deodorants.
   c. Appropriate uniforms must be worn when working with food.
   d. Five principles of personal cleanliness must be borne in mind. These protect the public and serve to protect you, the food handler, as well.
      (1) Keep the body clean by frequent use of soap and water.
      (2) Wash hands thoroughly with soap and water after visiting the toilet and always before handling food or food equipment.
      (3) Keep the hands and any unclean articles used by others for toilet purposes away from the mouth, nose, eyes, and genitals.
      (4) Avoid the use of common or unclean eating and drinking utensils or toilet articles such as towels, handkerchiefs, hairbrushes, and drinking cups.
      (5) Avoid close exposure to the spray from the nose and mouth of other persons.
   e. All food ordinances require personal cleanliness on the part of food handlers. (Section of sanitary code on cleanliness of food personnel may be read.)

B. Hand cleanliness on the part of the food handler is of tremendous importance.
   1. Outbreaks of food-borne disease have frequently been traced to food contaminated by persons with soiled hands.
      a. Many soiled articles are handled daily in the course of duties. A record of how hands are used during an ordinary working day will convince one that they must be washed frequently.
      b. To have clean hands one must have warm water, plenty of soap, and time for a thorough job. Dry the hands on paper towels.
      c. The history of "Typhoid Mary" teaches a valuable lesson in the importance of personal cleanliness. (Discuss food-borne typhoid caused by this famous carrier.)
      d. When working with food, hands must be kept away from nose, face, mouth, and hair. Head covering or hair nets should be required.
      e. Persons handling food must be free of boils, skin infections, and infected cuts, particularly on hands, arms, neck, and face.
      f. Material from skin infections getting into certain foods, particularly cream-filled pastries, may cause staphylococcus food-poisoning outbreaks. (Give history of an outbreak traced to such a source.)
      g. Personal health and cleanliness are the number one rule for all food

handlers. Careless personal habits and practices cannot be tolerated in the food business.

C. Service practices which relate to personal hygiene indirectly deserve some consideration. A neat, clean personal appearance, plus prompt, efficient service will increase patronage and please the customer.
   1. A few good service rules to keep in mind are:
      a. The food handler who gives prompt, courteous service is an asset to the business. A smile followed by "May I help you please?" puts the customer at ease.
      b. Feel clean!—Look clean!—Be clean! Cleanliness is the foundation of a well-conducted food business.
      c. Keep your hands immaculate. There is no place for dirty hands or nails in the food business.
      d. Use proper utensils. Do not serve butter with the fingers. Use forks, spoons, ladles, and dippers in transferring or dispensing food.
      e. If a side towel is carried, fold it over the forearm, don't carry it under the arm.
      f. Use a clean towel to wipe tables and counters. Even though clean, towels are best kept out of sight.

D. Slides are used with this lecture. All slides listed are 2-by-2 Kodachromes, as follows:
   1. Waitress correctly attired in neat, clean, well-fitting uniform.
   2. Waitress standing before mirror placing hair net.
   3. Food handler covering nose with clean handkerchief when sneezing.
   4. Food handler washing hands.
   5. View of neat, well-appointed dressing room.
   6. View of modern sanitary toilet room.
   7. View of large sign over wash basin directing employees to wash hands.
   8. Proper and improper position of side towel.

(The 16-mm. silent film "Eating Out," a production of the Flint, Michigan, Department of Health, or the U. S. Public Health Service's sound slide film "Service with a Smile," or the Texas film "From Hash Slinging to Food Handling" may be used with this lecture.)

These outlines and the visual educational materials listed have been used effectively in training courses for food handlers. However, the instructor should be on the alert for new techniques and educational aids which will increase the value of his instruction. While many successful courses have been held, there is always the opportunity to develop better methods and then to pass on to others suggestions that have proved effective.

For those wishing to explore this activity further the following references are suggested:

Andrews, John, and Champion, Frances T. A guide to safe food service. Washington, U. S. Public Health Service, Tentative Edition, February 1946, 65 pp.

Eskil, R. B. Food poisoning is avoidable. Hygeia, 21:716, October 1943.

Felsen, J. Food, fingers, and flies—dysentery and Salmonella infections. Hygeia, 21:502, July 1943.

Morgan, H. A., and others. Making food handlers health-conscious. American Journal of Public Health, 35:28, January 1945.

Physician, policeman, or pedagogue—control of food handlers. American Journal of Public Health, 34:756, July 1944.

Robertson, A. A. A course of instruction for food handlers. Journal of Milk Technology, 7:349–353, November–December 1944.

Texas State Department of Health. Food handling and disease prevention. Austin, Texas, February 1945, 80 pp.

Appendix G

SUGGESTIONS FOR EFFECTING CORRECTIONS IN SANITATION

The public health worker is basically an instructor and an educator. His constant aim is to improve conditions so that disease will be minimized or eliminated. Unfortunately, all persons with whom he comes in contact do not have a similar point of view. There are, however, certain procedures, listed below, that can be followed to bring about desired corrections. While these should be done progressively, extenuating circumstances or serious infraction may require more direct measures, such as license suspension or court action. The merit of the case and the judgment of the sanitarian will determine the most logical steps to follow.

1. Give advice and instruction directly to the person or persons involved.
2. Give clear and explicit written instructions, setting forth the time interval allowed for compliance. (Retain copy of instructions.)
3. Report violation to a superior officer, with request that a letter be written to violator ordering correction. (Registered mail, return receipt requested, may be used if necessary.)
4. Send written order to violator requiring him to be present for a hearing on the matter; decide disposition at hearing and take necessary follow-up action.
5. Require violator to sign written statement that correction will be completed within time interval agreed upon.
6. Suspend license if business is licensed under city ordinance and if health officer or his duly appointed agent has authority to take such summary action, suspension to continue until sanitary defect is remedied.
7. If (6) cannot be followed, assistance from either a state or a federal agency may be of aid.
8. Preliminary to instituting legal action, make re-inspection in company with a health officer, another sanitarian, or a state inspector. (Inspection by two or more persons frequently hastens corrective measures.)

Indirect methods may be used, such as making contact by phone, by letter, or by personal call to persons who may have influence with violator. These include business partner or associate, silent partner, wholesaler, or financial backer; domestic associates (wife, brother, children, parents, or other relative); and religious associates (rabbi, minister, or priest). In instances where business is operated as a branch, chain, or affiliate, contact local, district, or national office of the company.

Direct methods for dealing with a food ordinance violator may include:

1. Detention of food in establishment pending laboratory examination.
2. Condemnation of food.
3. Court action (warrant and summons).
4. Indictment for criminal action through proper legal channels (county or city attorney).

PREPARING CASES FOR LEGAL ACTION

1. The specific law and its many ramifications, weaknesses, and past cases tried under the law must be studied diligently.
2. The facts concerning the incidents must be carefully put down in writing—names (in full), dates, times, witnesses, and the specific violations.
3. Authorization from head of Department or Legal Department must be obtained before summons or warrant is issued.
4. Entire violation must be discussed with attorney for the official agency.
5. Facts of the case must not be discussed with others prior to trial.
6. A rehearsal of the case should be carried out and repeated with the prosecuting attorney.
7. In instances where no prosecuting attorney is available and the sanitarian has to carry out the proceedings with only the help of a superior, a second sanitarian should accompany him (for moral support).
8. All records, evidence, and exhibits must be kept in the possession of the sanitarian prior to the trial or locked in a safe place. If evidence is transferred from one person to another, signed receipts should be obtained.
9. The sanitarian must be thoroughly familiar with the procedure in sampling and submitting specimens for laboratory analysis. (Representatives of the Federal Food and Drug Administration are expert in this activity.)
10. Records after trials must not be destroyed or lost. They may be valuable in future cases.

Visits by the sanitarian to local police stations and city or county civil and criminal courts to observe procedures will facilitate and expedite his court cases.

Appendix H

CODE OF ETHICS FOR THE PUBLIC EMPLOYEE*

The Public Employee should:

1. Be ever mindful that he is but an integral part of the entire governmental structure
2. Perform his tasks to the best of his ability
3. Realize that his employment is not a personal right, but a privilege embodying a trust
4. Be courteous and considerate in all contacts with the public and his fellow employees
5. Maintain his dress and personal equipment in a manner consistent with the effective performance of his work
6. Appreciate the other fellow's point of view

He should avoid:

1. The acceptance of gratuities
2. The practice of nepotism
3. Private conduct that is likely to reflect adversely on the public service
4. Engaging in political activity in his official capacity
5. Irresponsible gossip about colleagues
6. Treading upon the rights of others to gain personal objectives

He should realize:

1. That disagreement with policy and practice should be voiced with his superiors
2. That when personal opinion conflicts with policy the latter should control his actions and utterances

* *From* The Sanitarian (National Association of Sanitarians, Los Angeles, Calif.), September 1938.

Appendix I

FACTS ABOUT DDT AND ITS USE AS AN INSECTICIDE

What is DDT?

The technical grade chemical is a harmless-looking, white, practically odorless powder resembling flour, especially flour with lumps in it, as the particles of pure DDT have a tendency to stick or clump together. Dichloro-diphenyl-trichloroethane is the chemical name for DDT.

What is DDT technical grade?

DDT technical grade is that which has a setting point of 89° C. or higher, meaning that degree of temperature at which a crystallized DDT will melt upon heating. The setting point of a para-para-prime DDT isomer is approximately 109° C., and for the ortho-para-prime isomer 65° C.

Any compound having the formula $C_{14}H_9Cl_5$ is an isomer of DDT. It has been calculated that there are forty-five possible DDT isomers. From the technical grade DDT only two isomers have been isolated—the para-para-prime isomer and the ortho-para-prime isomer. The former represents 65 to 73 per cent of the technical grade; the latter 19 to 21 per cent. The remaining parts of DDT technical are a small percentage of DDT isomers and some by-products of reaction, not DDT isomers at all but various chlorinated and sulphonated compounds classified as impurities. In ordering DDT technical grade the supplier should be advised that it must meet Army-Navy specifications, JAN–D–56, issued June 30, 1944.

*What is meant by a residual spray?**

DDT acts both as a contact and stomach poison. Its most unusual property is its lasting or residual effect. When DDT is sprayed or dusted on walls, ceilings, floors, and other surfaces, it leaves a deposit or residue of tiny crystals. If flies, mosquitoes, cockroaches, fleas, bedbugs, and certain other insects walk over or rest on this deposit long enough to obtain a sufficient exposure, they will be killed. The use of DDT as a coating or residual is quite different from that of ordinary fly spray. Space sprays which create a poisonous mist in the air and may not contain more than ½ to 2½ per cent DDT are not suitable for application where DDT residuals are desired.

How does DDT residue kill insects?

Just how DDT kills is not fully understood at present. Evidently it is absorbed through the insects' feet as they walk over a spray deposit or DDT

* The material from here to page 288 has been taken from two bulletins issued by the United States Public Health Service, Malaria Control in War Areas: "DDT for Control of Household Pests" and "Handbook of DDT Residual Spray Operations."

residue. After a short period of exposure, the affected insects become restless, drag their legs, and move about in a jerky and spasmodic manner. They may turn over on their backs and be unable to right themselves. Finally they may develop tremors and die, although death may not take place until hours later.

Mosquitoes and flies often move toward the light when they are first affected. After they receive a toxic dose of DDT, they may fly away and die elsewhere. So the user should not be disappointed at not finding a large number of dead insects after an area has been treated. The best test of DDT's effectiveness is the absence of live insects, not the presence of dead ones. However, flies, cockroaches, and other insects may reinfest the premises from outside sources. If this happens, live insects may be seen before they have received a toxic dose, thus giving the erroneous idea that the spray is ineffective. Every effort should be made to prevent this reinfestation by other sources, even though residual sprays are used.

Preparation of DDT residual sprays

Solutions of DDT can be prepared by using highly refined, deodorized, *white* kerosene or some other commercial solvents regularly used in ordinary fly sprays. For effectiveness as a residual spray, oil solutions must contain at least 5 per cent DDT. Weaker solutions of DDT, 1 to 2 per cent or less, require such large amounts of spray that it is impractical to try to get enough on a wall or other surface to give an effective residue.

A 5 per cent DDT solution may be prepared by dissolving seven ounces of DDT technical grade in each gallon of oil or commercial solvent. Before using the spray solution, it should be strained to remove particles that may clog the spray nozzle. In the average household, one cup of 5 per cent spray is sufficient to treat effectively each 60 square feet of surface against flies and mosquitoes for about three months. When it is applied to newly painted surfaces, the effect is lost rapidly. Dust and grease deposits covering treated surfaces reduce the length of effectiveness. Vibrations cause a flaking-off of the DDT deposit, and shorten the period of residual effect.

Preparation of DDT emulsion concentrate

Although DDT can be applied in various oil solutions such as kerosene, many of these materials dissolve only small quantities of DDT and others may stain walls and fabrics. For this reason, xylene has been selected as a solvent since it dissolves relatively large quantities of DDT, does not stain, and is fairly cheap. In order to spray the small quantities of DDT desired, further dilution with water is necessary.

Since DDT-xylene solution does not mix with water, the two liquids will very quickly separate after shaking. To prevent this, a DDT-xylene emulsion, using Triton X–100 as an emulsifying agent, has been developed.

An *emulsion* differs from a solution. DDT readily dissolves in xylene to

form a DDT-xylene *solution;* but if water is added, the two liquids do not mix. When shaken violently, the DDT-xylene breaks up into tiny drops which are dispersed throughout the water. If allowed to stand, the tiny drops of DDT-xylene come in contact with one another. When two touch, they combine to form a larger drop and so on—until the DDT-xylene and the water have separated.

If an emulsifier such as Triton is added to the mixture and the material shaken vigorously, the DDT-xylene is broken up into little drops and dispersed throughout the water. In this instance, each drop of DDT-xylene is surrounded by a thin layer of emulsifier. This prevents them from joining, and the many tiny drops of DDT-xylene remain suspended in the water giving it a milky appearance. This is an *emulsion* of DDT-xylene in water.

Shipping a ready-to-use DDT-xylene emulsion spray is not economical since the finished spray contains about 93 per cent water. To avoid transporting such large quantities of water, a DDT-xylene-Triton emulsion *concentrate* has been developed. This can be diluted with the proper amount of water at the spraying site.

Xylene will dissolve more DDT at higher temperatures. For this reason, a 35 per cent DDT concentrate is used in the summer when temperatures are above 60° F. In the winter or early spring, when temperatures are below 60° F., a 20 per cent DDT concentrate must be used. The basic formulas for these different concentrates are given below:

	Summer formula	*Winter formula*
DDT	3 lbs.	1 lb.
Xylene	3 qts.	2 qts.
Triton	6 fluid oz.	3.2 fluid oz.
	1.03 gals.	0.6 gal.

To prepare the DDT spray in the proper dilution, mix one part of summer concentrate with 13 parts of water or one part of winter concentrate with 7 of water. This will result in a 2½ per cent (not a true percentage—expressed in percentage for simplicity) DDT spray containing 25 mg. DDT/cc. of spray solution. When this milky liquid is sprayed on a surface, the water and xylene evaporate, leaving the desired residue of DDT crystals.

DDT suspensions

A DDT powder containing a chemical which permits the DDT particles to be mixed readily with water may also be used as a residual spray. In this mixture, called a suspension, small particles of DDT are distributed evenly throughout the liquid.

A 5 per cent DDT spray is prepared from such a DDT powder by diluting it with water. The amount of water necessary depends upon the concentration

of DDT in the commercial product. The manufacturer's label should supply this information.

The DDT suspension can be sprayed on surfaces. It has no odor, presents no fire hazard, and is harmless when applied to the skin of man or to the coats of animals. When the water evaporates, small flecks of both DDT and the carrier remain on the sprayed surface. So the spray shows as a white spotting on dark surfaces such as dark-stained furniture, dark-colored paints, varnished floors, and window glass. However, it is very effective and is easy to apply where spotting is unimportant.

DDT powders or dusts

A number of dry mixtures of DDT are available for dusting. These contain 5 to 10 per cent DDT diluted with some powder, such as talc or pyrophyllite, which serves as a carrier. The usual dilution is one part of DDT in 9 parts of carrier. For most home use, the dust should contain no less than 10 per cent DDT.

Use of DDT against various insects

House Flies—Use DDT as a 5 per cent residual spray. Apply with hand sprayer, large air pressure garden sprayer, wide paint brush, or roller applicator. Spray surfaces where flies are most likely to light. Treating an entire room may not be necessary.

Cockroaches—A 10 per cent DDT powder is effective for treating the hiding places of the roach. Use a small hand dust gun to force the dust into cracks and crevices, along shelving, behind equipment, cupboards, and sinks. Allow time for the dust to take effect. A week may elapse after the dust is used before any marked reduction of infestation is noticed.

For quicker results a 5 per cent oil solution, suspension, or emulsion may be used. Most of the roaches will be killed almost immediately if the spray contacts them. A combination of spraying and dusting will be found most effective in roach control. Painting a DDT solution on cupboard shelves, undersides of tables, counters, etc., is an efficient way to treat these surfaces, with special attention given to crevices and small openings where these insects hide. DDT has killed roaches a month after original application, but its effect is most noticeable during the first week after spraying.

Bedbugs—Apply a 5 per cent spray to bedsteads and mattresses. A small hand sprayer can be used. A single treatment is effective for six months or longer. In heavy infestations walls, cracks along baseboards, surfaces behind loose wall paper, and similar hiding places should be treated. About ½ cup of 5 per cent spray should be sufficient for each bed.

Ants—Certain species of ants can be controlled with DDT. First, locate their entrances to the premises and treat those areas with a heavy spray or dust deposit. A 5 per cent spray solution or 10 per cent powder may be used.

Silverfish—The general treatment recommended for cockroaches will be equally effective against silverfish.

*Precautions for the use of DDT**

1. Do not spray food, dishes, toys, or other articles from which the material may be taken internally.
2. Wear rubber gloves while spraying or handling materials or freshly sprayed surfaces.
3. Wear face mask or respirator while spraying or while in the room during treatment, especially if sprayer vaporizes material greatly.
4. Wash hands, arms, or face with warm water and plenty of soap suds if material is spilled on them.
5. Avoid spilling on mattresses or upholstery, or over-spraying smooth hard surfaces, especially mohogany or dark-colored surfaces, because white streaking will result if the spray runs.
6. Do not spray near open flames.
7. Do not smoke or eat until hands and face are thoroughly washed.
8. Take hot showers, using plenty of soap suds.
9. Saturated or sprayed clothes should be laundered after spraying.
10. In case any appreciable amount of DDT is swallowed, one should take a tablespoon of mustard in a glass of warm water.

DDT is not harmful to animals or humans after spray dries.

The following bulletins on DDT are available from the United States Public Health Service, Malaria Control in War Areas, 605 Volunteer Building, Atlanta, Georgia: "DDT for Control of Household Pests," "Handbook of DDT Residual Spray Operations," "Larviciding," and "DDT Residual Spray Operations."

* From the News Letter of the National Pest Control Association, Brooklyn, N. Y.

APPENDIX J

PARTIAL LIST OF FILMS RELATING TO MILK AND FOOD SANITATION*

Sources from which films may be available for loan or rent

State departments of health
District offices of the U. S. Public Health Service
State departments of education
University extension divisions
Health Officers News Digest, 1790 Broadway, New York 19, N. Y.
Y. M. C. A. Motion Picture Bureau, 347 Madison Ave., New York 17, N. Y.
Castle Films, Inc., 30 Rockefeller Plaza, New York 20, N. Y.

Film catalogs

ONE THOUSAND AND ONE, 75¢, The Educational Screen, 64 E. Lake St., Chicago 1, Ill.

HEALTH FILMS, 25¢; supplements 20¢. Two supplements issued to date. American Film Center, Inc., Section on Health and Medical Films, 45 Rockefeller Plaza, New York 20, N. Y.

SOUND FILMS FOR THE CLASSROOM, Erpi Classroom Films, Inc., 1841 Broadway, New York 19, N. Y.

Key to listing of films for suitability. (Those marked with an asterisk are specially suited for the purpose indicated.)

(1) For schools for foodhandlers
(2) For schools for milk handlers
(3) For food sanitation seminars for sanitarians
(4) For milk sanitation seminars for sanitarians
(5) For the general public
(6) Listed in various catalogs but not viewed

GENERAL RESTAURANT SANITATION

Eating out (1940) (1*, 3*, 5*) 26 min., silent, 16 mm., black and white. City Health Department, Flint, Michigan. Contrasts insanitary foodhandling practices with proper methods as used in a well-managed eating place and finally reviews the rules for good food-handling and restaurant sanitation.

Hashslingin' to foodhandling (1945) (1*, 3*, 5*) 20 min., sound, 16 mm., color. Texas State Department of Public Health. Sanitary and insanitary methods of handling food and utensils are demonstrated by a sloppy waitress (a Hashslinger) and a well-trained waitress (a Foodhandler). Dark

* Issued by the Federal Security Agency, United States Public Health Service, Washington, D. C., January 1946.

coloring material is used to illustrate the travel of germs from the mouth of a customer to utensils, the Hashslinger's hands and mouth, and another customer. Good, sanitary service protects the health of customers and employees and brings larger tips to waitresses and greater profits to the management.

In your hands (1939) (1*, 3*) 22 min., sound slide film, black and white. Public Health Committee of the Cup and Container Institute, 1790 Broadway, New York 19, N. Y. An inspector discusses the reasons for and methods of proper cleaning and sanitization of eating and drinking utensils with a soda fountain operator and bartender. The use of paper cups is emphasized. (When used at foodhandlers' schools, it should be explained that the health department considers both properly sanitized utensils and paper utensils to be satisfactory.)

It's no picnic (1941) (1*, 3*, 5) 10 min., sound, 16 mm., black and white. New Mexico School Supply Co., 207 W. Copper Ave., Albuquerque, N. M. A picnic results in food poisoning. Bacteriological follow-up incriminates the potato salad, infected by improper handling. Correct foodhandling practices are shown.

Our health in your hands (1945) (1*, 3*, 5) Series of four 10–15 minute sound slide films, black and white. Castle Films, Inc., 30 Rockefeller Plaza, New York 20, N. Y. ($10 for complete series; $9 to non-profit institutions.)

1. *Germs take pot luck.* The spread of disease in restaurants is discussed and dramatized; the habits of germs are shown by cartoons; the importance of each restaurant worker's part in preventing the spread of disease is pointed out.
2. *Service with a smile.* A customer visits a restaurant where proper serving methods as well as good food are featured. His waitress demonstrates correct methods and explains the more important rules of personal hygiene and cleanliness. The manager discusses the employee training program and the importance of providing the essential sanitary facilities.
3. *In hot water.* An inspector discusses the customers' reaction to unclean eating utensils, the health hazards involved, and the importance of proper dishwashing. Good manual methods are shown in a step-by-step sequence. Machine dishwashing, glass washing, and the cleaning of cooking utensils are briefly covered.
4. *Safe food for good health.* A county health officer emphasizes that food must be safe as well as nutritious. He visits a restaurant where the manager and several employees discuss proper selection, preparation, storage, and protection of food and the elimination of flies, roaches, rats, and mice. After a brief summary of the four strips, the importance of overall cleanliness is again emphasized.

Slinging hash (1940) (1*, 3) 15 min., silent, 16 mm., black and white. Texas State Department of Health, Austin, Texas. Using an average restaurant

as a background, the film explains graphically the sanitary and insanitary handling of food and eating utensils.

The community cup (6) 15 min., silent, 16 mm., black and white. West Virginia State Department of Health, Charleston, W. Va.

The danger point (1943) (1*, 3*, 5*) 12 min., sound, 16 mm., color. Public Health Committee of the Cup and Container Institute, 1790 Broadway, New York 19, N. Y. Discusses the spread of respiratory diseases and prevention by proper foodhandling sanitation. Transmission by improperly sanitized glasses is demonstrated. The use of paper cups is emphasized. (When used at foodhandlers' schools, it should be explained that the health department considers both properly sanitized utensils and paper utensils to be satisfactory.)

Tommy Fork and his fountaineers (1945) (1*, 3*) 10 min., sound slide film, black and white. Syndicate Store Merchandiser, Inc., 79 Madison Ave., New York 16, N. Y. Using a soda fountain background, animated eating utensils and a counter-girl interestingly and humorously demonstrate proper handling and serving of food and utensils. Personal appearance is briefly covered. A silent photo-quiz trailer is included for audience participation.

'Twixt the cup and the lip (1940) (1*, 3*, 5*) 22 or 13 min., sound, 16 mm. or 35 mm., black and white. G. S. Jacobsen, 204 Washington Ave., Albany, N. Y. After an outbreak of colds, the health department goes into action to obtain good dishwashing or single-service utensils at local restaurants. Shows proper methods of sanitization of multi-use utensils and methods of examination. Long version includes information on detergents. (For use at foodhandlers' schools, the sequence referring to "this cheap help" should be deleted.)

BACTERIOLOGY AND COMMUNICABLE DISEASE

Another to conquer (1941) (1, 2, 3, 4, 5*) 18 min., sound, 16 mm., black and white. National Tuberculosis Association, 1790 Broadway, New York 19, N. Y. Diagnosis and treatment of tuberculosis among the American Indians of the Southwest. Excellent pictorial photography.

Body defenses against disease (1937) (1*, 2*, 3*, 4*, 5*) 11 min., sound, 16 mm., black and white. Erpi Classroom Films, Inc., 1841 Broadway, New York 19, N. Y. Animated portrayal of the body's three lines of defense against disease. Microphotographs show the action of phagocytic cells in attacking and engulfing bacteria.

Confessions of a cold (1, 2, 5) 10 min., sound; 15 min., silent; 16 mm., black and white. National Motion Picture Co., Mooresville, Ind. The dangers of the common cold and how to treat it. Animation used to emphasize the method of infection.

Goodbye Mr. Germ (1940) (1, 2, 5) 14 min., sound, 16 mm., black and white. National Tuberculosis Association, 1790 Broadway, New York 19, N. Y. Animated cartoon on the transmission of tuberculosis.

Let my people live (1938) (1, 2, 5) 15 min., sound, 16 mm., black and white. National Tuberculosis Association, 1790 Broadway, New York 19, N. Y. Tuberculosis control in the South. Colored cast. Excellent sound including the Tuskegee Choir.

Man against micrcbe (1932) (6) 10 min., sound; 15 min., silent; 16 mm., black and white. Metropolitan Life Insurance Co., New York, N. Y. Dramatizes discoveries that were decisive in the fight against infectious disease.

Preventing the spread of disease (1, 2, 5) 10 min., sound; 15 min., silent; 16 mm., black and white. National Motion Picture Co., Mooresville, Ind. Stresses measures which the individual and community may use to reduce the amount of communicable disease.

FLIES

Swat the fly (1936) (1*, 2*, 3*, 4*, 5*) 10 min., sound, 16 mm., black and white. Edited Picture System, 330 W. 42nd St., New York 18, N. Y. Development and anatomy of the housefly; its role in disease transmission and some methods of control.

The housefly (1935) (1*, 2*, 3*, 4*, 5*) 10 min., sound, 16 mm., black and white. Erpi Classroom Films, Inc., 1841 Broadway, New York 19, N. Y. Life cycle of the fly; its role in disease transmission; methods of control.

The housefly (1933) (6) 15 min., silent, 16 mm., black and white. Eastman Kodak Co., Rochester, N. Y. Life cycle of the fly; its role in disease transmission; some methods of control.

MILK

All washed up for clean safe milk (2*, 4) 15 min., sound slide film. Audi-Vision, Inc., 285 Madison Ave., New York 17, N. Y. Prospective plant-producer discusses the sanitation requirements with the milk sanitarian and observes good methods at a neighbor's dairy.

From moo to you (6) 10 min., sound, 16 mm., color. The Borden Co., 350 Madison Ave., New York 17, N. Y. Animated cartoon in which Elsie, the cow, tells the story of milk.

Home of the free (1941) (1, 2, 5*) 11 min., sound, 16 mm., color. National Dairy Council, 111 N. Canal St., Chicago 6, Ill. The role of milk nutrition in the national emergency; scenes in army kitchens and messes and in the home; illustrating proper selection and preparation of food.

Milk (6) 10 min., sound, 16 mm., black and white. Bell & Howell Co., 1801 Larchmont Ave., Chicago 13, Ill.

Milk and its products (6) 10 min., sound, 16 mm., black and white. Films Incorporated, 330 W. 42nd St., New York 18, N. Y.

Milk parade (5*) 10 min., sound, 16 mm., black and white. Milk Industry Foundation, Chrysler Bldg., New York 17, N. Y. Steps in the production, pasteurization, and bottling of milk.

Milk production (6) 16 mm., silent. Illinois State Health Department, Springfield, Ill.

Milk—the master builder (6) 10 min., sound; 15 min., silent; 16 mm., black and white. National Motion Picture Co., Mooresville, Ind. Nutritional value of milk and milk products.

Milk—white magic (6) 30 min., sound, 16 mm., color. The Borden Co., 350 Madison Ave., New York 17, N. Y.

Miracle of the meadow (6) 25 min., sound, 16 mm., black and white. Bailey Film Service, P. O. Box 2528, Hollywood, Calif.

Modern magic (1943) (2, 5*) 16 min., sound, 16 mm., color. Parrott Film Studios, 1700 Keo Way, Des Moines, Iowa. Stresses the importance of good milk. Does not give detailed procedures of milk production and processing.

More life in the living (1939) (1, 2, 5*) 12 min., sound, 16 mm., black and white. National Dairy Council, 111 N. Canal St., Chicago 6, Ill. An entertaining and stimulating film emphasizing the role of milk in nutrition.

More milk (1944) 11 min., sound, 16 mm., black and white. U. S. Department of Agriculture, Motion Picture Service, Washington, D. C. A film designed to promote greater milk production. Not suitable for milk handlers' sanitation courses unless it is desired to urge increased milk production at the course.

Quality milk (2) 15 min., silent, 16 mm., black and white. U. S. Department of Agriculture Motion Picture Service, Washington, D. C. The production of quality milk from the producer to the milk plant. An old film.

Quality milk production (1944) (2*, 4*, 5) 33 min., sound, 16 mm., black and white. National Dairy Products Corp., 230 Park Ave., New York 17, N. Y. The importance of safeguarding milk by using sanitary production methods is stressed. Proper methods are shown, including barn cleaning, grooming of cows, washing udders with chlorine water, use of strip cup, use of milking machine including manipulation of udder, prompt straining and cooling, and protection during hauling. Sequences on cleaning of utensils stress the use of brushes, soapless cleaner, hot water, disassembly of milking machines, and chlorine rinse before use. Sequences at the milk plant show platform and laboratory tests with follow-up by field man. At end the film stresses the importance of training of future dairy farmers in FFA and 4-H.

Safeguarding the milk of millions (1944) (2*, 4*) 30 min., sound, 16 mm., color. Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill. Deals chiefly with the construction of milk houses, cooling tanks, and barns, stressing the use of cement.

Sentinels of milk (1944) (2*, 4*, 5*) 16 min., sound, 16 mm., color. R. Hunter, 1105 East Grand River, East Lansing, Mich. Milk production, pasteurization, and bottling. Stresses sanitation and gives good information on cleaning and sanitizing milking machines.

The milky way (4*) 25 min., sound, 16 mm., color. The Diversey Company, 53 W. Jackson St., Chicago 4, Ill. The bactericidal treatment of dairy farm

and pasteurization plant equipment, stressing the use of hypochlorites. A commercial film.

The problem of bacteria in milk (2*, 4) 14 min., sound slide film. William M. Hickman, Pennsylvania Salt Manufacturing Company, 1000 Widener Bldg., Philadelphia 7, Pa. A humorous film using cartoons to explain bacteriology to farmers and producers. Sound on reverse of record for *What are bacteria?*

The story of milk (6) 20 min., sound, 16 mm., black and white. Bailey Film Service, P. O. Box 2528, Hollywood, Calif.

What are bacteria? (2*, 4) 13 min., sound slide film. William M. Hickman, Pennsylvania Salt Manufacturing Company, 1000 Widener Bldg., Philadelphia 7, Pa. A humorous film using cartoons to explain bacteriology to farmers and producers. Sound on reverse of record for *The problem of bacteria in milk.*

Your daily milk (4, 5) 10 min., sound, 16 mm., color. Milk Industry Foundation, Chrysler Bldg., New York, N. Y. Modern milk distribution with emphasis on economics. Animated charts of the milk distributor's dollar.

NUTRITION

Food and nutrition (1, 3, 5) 11 min., sound, 16 mm., black and white. Erpi Classroom Films, Inc., 1841 Broadway, New York 19, N. Y. Normal dietary requirements of carbohydrates, fats, proteins, minerals, and water. Rather technical for foodhandlers. Contains no information on sanitation.

Hidden hunger (1942) (5*) 22 min., sound, 16 mm., black and white (color trailer). "Hidden Hunger," 420 Lexington Ave., New York 17, N. Y. Dramatic film on nutrition. Crusading farmer campaigns to reform the nation's eating habits. Shows correct cooking procedures to preserve vitamins.

Meat and romance (1, 3, 5*) 40 min., sound, 16 mm., black and white (color trailer). Castle Films, Inc., 30 Rockefeller Plaza, New York 20, N. Y. Correct procedures in buying, cooking, and carving meats; nutritional value of various meats. Although too long for general use of foodhandler schools, it is considered excellent for those operators who might wish to remain after the regular session.

What's cookin'? (1, 3, 5*) 15 min., sound slide film. Zurich General Accident and Liability Insurance Co., Chicago, Ill. A film stimulating interest in nutrition. Restaurant setting.

RODENT CONTROL

Keep 'em out (1942) (1*, 2*, 3*, 4*, 5*) 10 min., sound, 16 mm., black and white. U. S. Public Health Service, Washington 14, D. C. Expository film; how rats spoil food, destroy property, and spread disease; rat control by poisoning, trapping, and ratproof construction.

Rat destruction (1942) (6) 10 min., sound, 16 mm., black and white. British Information Service, 30 Rockefeller Plaza, New York 20, N. Y.

Vandals in the night (1*, 2*, 3*, 4*, 5*) 20 min., sound, 16 mm., color. Acting Director, Fish and Wildlife Service, U. S. Department of Interior, Merchandise Mart, Chicago 54, Ill. An excellent film emphasizing the economic reasons for rat control in cities and rural areas.

REFRIGERATION

40 billion enemies (1941) (1, 3, 5*) 25 min., sound, 16 mm., color. Westinghouse Electric & Manufacturing Co., Visual Education Section, Mansfield, Ohio. Contains good information on maintenance and use of home refrigeration units and the storage of different foods. The causes of spoilage and the influence of temperature on germ growth are explained. No commercial message.

How to get the most out of your refrigerator (1941) (1, 3, 5*) 30 min., sound, 16 mm., black and white. General Motors, Department of Public Relations, 1775 Broadway, New York 19, N. Y. Information on the care and use of home refrigeration units and the storage of different foods. No commercial message.

WATER AND PLUMBING

City water supply (6) 10 min., sound, 16 mm., black and white. Erpi Classroom Films, Inc., 1841 Broadway, New York 19, N. Y.

Contamination of water supplies by back siphonage (1937) (3*, 4*, 5) 20 min., sound, 16 mm., black and white. University of Minnesota, Bureau of Visual Education, Minneapolis, Minn. Several types of faulty plumbing fixtures are shown and proper corrective measures explained. Laboratory models illustrate back-siphonage.

Every drop a safe one (1939) (6) 11 min., sound; 15 min., silent; 16 mm., black and white. National Motion Picture Co., Mooresville, Ind.

Safe drinking water from small supplies (1939) (3*, 4*, 5*) 12 min., sound, 16 mm., black and white. University of Minnesota, Bureau of Visual Education, Minneapolis, Minn. Correct measures for the installation of small water supplies. Bored, drilled, and driven wells illustrated diagrammatically.

Safe water (1943) (3*, 4*, 5*) 15 min., sound slide film. U. S. Public Health Service, Washington 14, D. C. The importance of safe water, with emphasis on country supplies.

The ominous arms case (1942) (3*, 4*, 5*) 30 min., sound, 16 mm., black and white. Pure Water Films Company, 1251 N. Clark St., Chicago 10, Ill. Using a story based on a lawsuit, the film shows that disease may result from the drinking of polluted water caused by back-siphonage.

Appendix K

PRECISION TESTING OF HIGH-TEMPERATURE SHORT-TIME PASTEURIZERS

The use of high-temperature short-time pasteurization has increased rapidly in recent years, and indications are that its popularity as a method of pasteurizing milk and dairy products will continue to grow. The equipment now available to the milk processor is precision built and equipped with many sensitive controls (see Figure 63) which, when used under correct operating conditions, insure the proper pasteurization of milk. Heating milk to a temperature of not less than 160° F. and holding it at such temperature for not less than fifteen seconds has been demonstrated to be effective in the destruction of pathogens which may be present in the milk. Milk pasteurized by the high-temperature method in properly installed and operated equipment satisfactorily fulfills the definition of pasteurization.

One of the major concerns of the milk sanitarian in relation to the use of this equipment is to be certain that every particle of milk passing through the holding tube under normal operating conditions is at the correct temperature (not less than 160° F.) and is held for the correct time (not less than fifteen seconds).

To ascertain whether this fine temperature-time combination obtains, certain apparatus has been developed which will permit an accurate determination to be made. At present there are two methods which may be employed: the first involves using a colored dye solution (methylene blue, or uranine dye) and observing the time required for the solution to pass through the holding tube of the pasteurizer; the second consists of introducing a salt solution of high conductivity near the upstream end of the holding tube, and, by employing appropriate measuring devices, determining the time required for the injected solution to reach the downstream end of the holding tube with the equipment operating under normal conditions. Experience has demonstrated that tests employing a salt solution give accurate results and overcome such objections to the dye method as staining of equipment and possibility of human error and decreased accuracy. In this discussion the procedure given pertains to the use of the salt solution only.

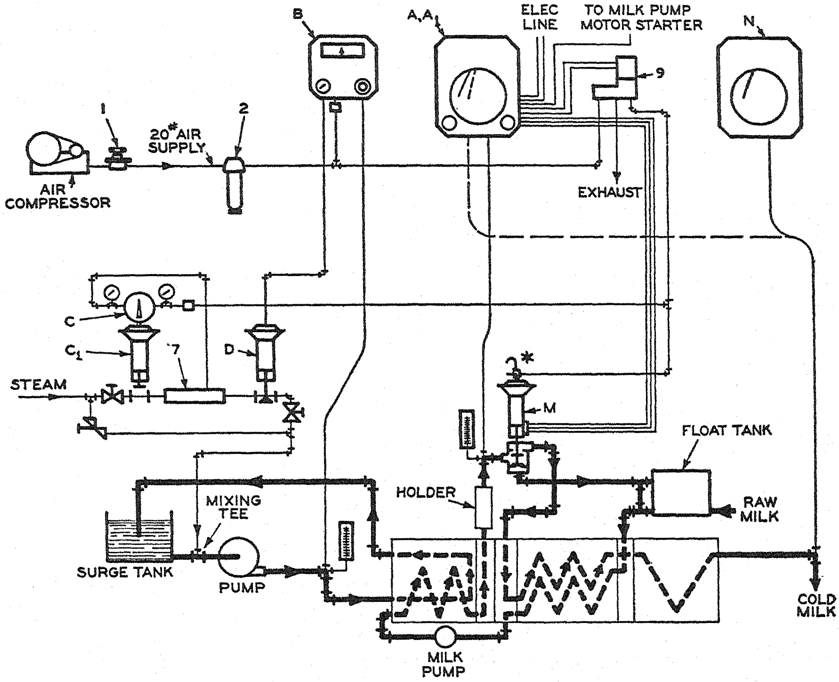
It should be noted at this point, moreover, that the following discussion is limited mainly to the apparatus needed for conducting the timing test and the procedure to follow. There are other tests which should be made, especially to insure the accuracy of thermometer equipment. For this the reader is referred to Item 16p, Pasteurization, pp. 96–115, in the 1939 edition of the Milk Ordinance and Code Recommended by the United States Public Health Service.

Description of Operation for Figure 63

Steam pressure is controlled by "C" and "C_1" set about 15 psi below minimum line or boiler pressure, to provide a constant steam pressure ahead of the control valve "D."

The milk temperature is controlled indirectly by maintaining the water inlet temperature at a given value by controller "B," with its bulb located in the outlet from the water circulating pump, actuating diaphragm valve "D" and thus regulating the quantity of steam necessary for maintaining a constant water temperature.

The Safety Thermal Limit Recorder Controller "A," with the bulb in the milk outlet from the holder, records the temperature of the milk leaving the holder. If the milk temperature falls below the predetermined minimum, it actuates solenoid valve "9," bleeding the air from the top of the flow diversion valve "M," the disc of which moves upward to divert milk. This same air supplies pressure controller "C." With no air supplied to controller "C," valve "C_1" is wide open, allowing all available boiler steam pressure to be used for heating the water in the shortest possible time. This feature, known as accelerated heating, provides first for quick recovery of the milk temperature both in the initial heating period and also in case of subsequent diverted flow. Second, it permits setting pressure controller "C" at the correct value for optimum performance of water temperature controller "B," without being concerned that this pressure might be too low for quick recovery. The Safety Thermal Limit Recorder also provides on the outer edge of the chart a record of the frequency and duration of the flow diversion which is actuated by the micro-switch on the flow diversion valve.

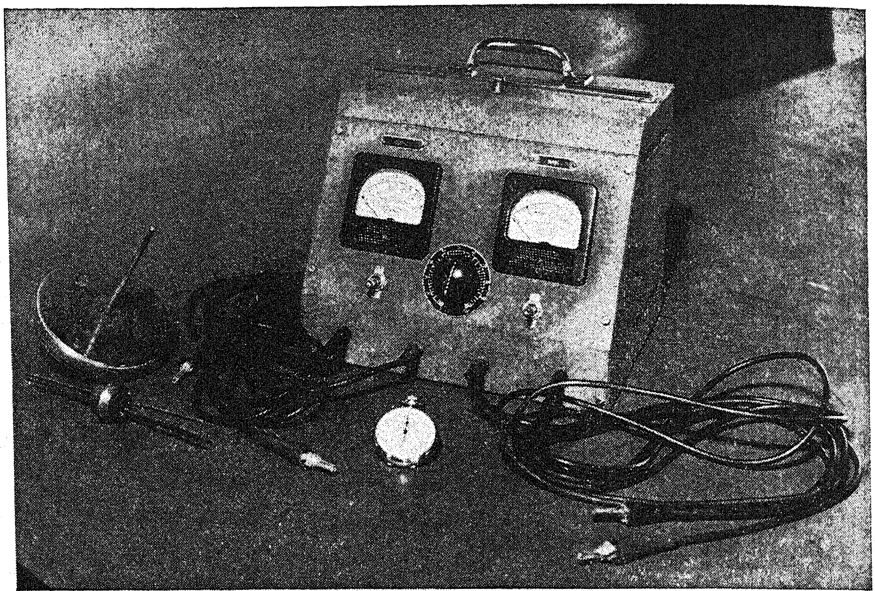


NOTE: SOLENOID VALVE IS SUPPLIED ON MOUNTING BRACKET OF FLOW DIVERSION VALVE. FOR CONVENIENCE THEY ARE SHOWN SEPARATED.

* - OPTIONAL. SUPPLIED AS STANDARD FOR INSTALLATIONS IN NEW YORK CITY AREA.

Courtesy Taylor Instrument Cos., Rochester, N.Y.

Figure 63. Air-operated control system for high-temperature short-time pasteurization



Courtesy Dr. A. C. Fay, H. P. Hood & Sons, Boston

Figure 64. Apparatus for making timing tests: a manually controlled ammeter box with resistance coil, lead wires, one double-type electrode, one single-type, and a stop watch

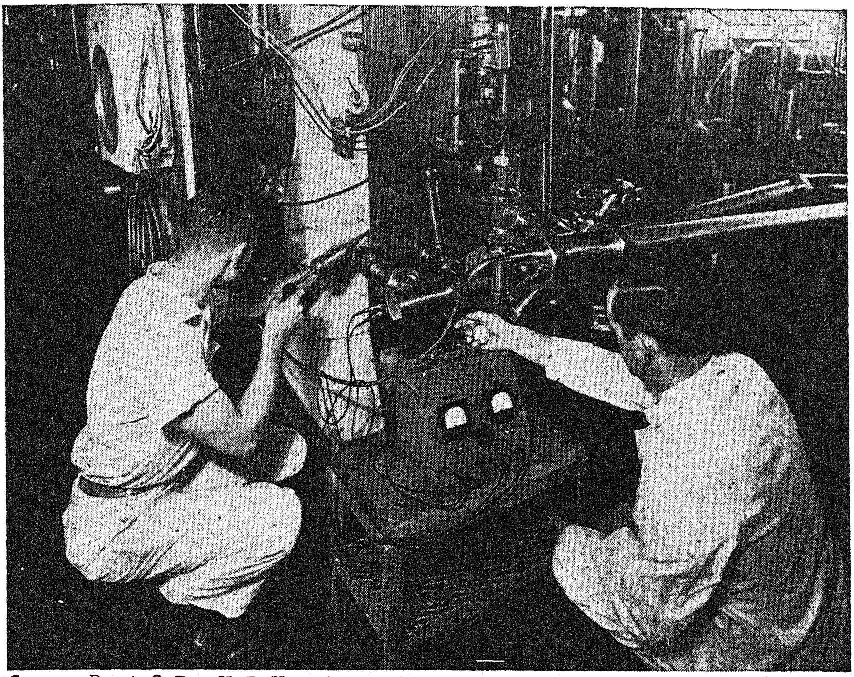
APPARATUS REQUIRED FOR MAKING THE TIMING TEST* (SEE FIGURE 64)

1. One ammeter registering 25 milliamperes with electric wire leads and a second registering 5 milliamperes with wire leads, both in a resistance box and each ammeter connected with a dry cell through a switch and two lead wires. The knob on the dial in the center of the box is connected with a resistance coil to be used only when the conductivity of the water supply used to operate the pasteurizer during the testing period is sufficiently high to deflect the needles of the ammeters before the salt solution is injected. Under these conditions the ammeter is less sensitive and the measurements less accurate.

2. Double type electrodes. One set for use at the upstream end of the tube made by inserting two brass or copper wires through a two-hole rubber stopper in a beveled metal ring. A second set for use at the downstream end of the holding tube made by inserting two brass or stainless steel rods about six inches long through holes bored in a cap end plate. These rods are insulated from the cap end plate by plastic sleeves.

3. A special cap end with one-half-inch threaded brass pipe fittings to be inserted at the opening normally occupied by the indicating thermometer

* Fay, A. C., and Fraser, Joseph. Precision timing of short-time high-temperature pasteurizers. Journal of Milk Technology, 6:321–330, November–December 1943.



Courtesy Dr. A. C. Fay, H. P. Hood & Sons, Boston

Figure 65. Timing test about to be started, showing properly connected equipment ready for operation

between the outlet of the final heater section and the upstream end of the holding tube.

4. An alemite gun or large veterinary type syringe with appropriate fittings. The fitting where the alemite gun is connected is provided with a small stopcock to permit removal of the alemite gun for refilling without removal of the cap end from the line.

5. A stop watch.

6. A saturated salt (sodium chloride) solution.

PROCEDURE FOR MAKING THE TIMING TEST

1. The ammeter labeled "input" (25 milliamperes) is connected with the electrodes located in the upstream end of the holding tube, and the ammeter labeled "output" (5 milliamperes) is connected with electrodes in the downstream end of the holder.

2. With the electrodes properly mounted and connected to the ammeter box, the alemite gun or syringe full of saturated salt solution and connected to the assembly as shown in Figure 65, and the pasteurizer operating with water instead of milk at normal temperatures so as to keep the flow-diversion valve in the forward-flow position, the measurement is ready to be made. The

stopcock in the half-inch brass pipe connecting the alemite gun and the "milk" line is opened and immediately the salt solution is injected by shoving the piston of the alemite gun forward. The pressure applied to the piston of the alemite gun should be firm but not sufficiently rapid to encourage driving of the salt solution into the tube at a rate faster than the normal speed of the flow of the water (or milk) through the tube. The pressure applied should also be uniform with replicate measurements. It is important to note that the salt solution is injected into a tube which is at right angles to the holding tube. This is done to avoid channeling of the salt, which might occur if the alemite gun were attached to the inlet cap end of the holding tube and the salt solution forced directly into the channel of the stream.

Almost immediately after the salt solution is injected (see Figure 65), the needle on the input ammeter will be suddenly deflected because the ions of salt have greatly increased the conductivity of the water separating the electrodes in the upstream end of the holding tube, thereby completing the circuit of the battery and the ammeter. The stop watch should be started at the first deflection of the needle of the input ammeter. At this time the needle on the output ammeter shows no deflection because the electrodes are separated by pure water, which is a poor conductor. The instant the injected salt ions reach these output electrodes, however, the needle shows deflection, and the watch should be stopped. Although a large amount of salt is injected, it is sufficiently diluted in its travel around the holding tube to make the deflection of the needle on the output ammeter less sharply defined than is obtained with the input ammeter. For this reason, a more sensitive ammeter is needed for the output assembly and more attention must be given to the sensitivity of the electrodes employed at this point. The electrodes may be rendered more sensitive by making them longer or by placing them closer together, but they should not be so long as to extend beyond the "T" fitting in the end of the holding tube. There is a practical limit, however, beyond which the sensitivity of the output assembly should not be increased, because the normal conductivity of the water may cause deflection of the ammeter and thereby interfere with accurate determinations. Although some difficulty may be encountered in determining just the instant to stop the watch, reasonably uniform replicate determinations can be made with a little experience and perhaps some trial-and-error readjustments of the electrodes at the output end of the assembly.

While this discussion has been devoted primarily to a method of precision testing of high-temperature equipment, first-hand experience in the field will serve to crystallize in the sanitarian's mind the actual steps to follow. To insure a thorough technical knowledge of the entire process, assistance and advice should be enlisted from state milk sanitarians in connection with this work, manufacturers' catalogs should be consulted, and careful observations made in plants where high-temperature pasteurization is used.

In addition to the Fay and Fraser article from which much of the material in this discussion is quoted, the following publications may be consulted on the general subject of high-temperature pasteurization:

Farrall, Arthur W. Dairy engineering. New York, John Wiley & Sons, Inc., 1942.

Federal Security Agency, U. S. Public Health Service. Milk ordinance and code recommended by the U. S. Public Health Service, Public Health Bulletin 220, Washington, D. C., 1939.

Journal of Milk Technology, September–October 1944. A series of four articles on certain aspects of high-temperature pasteurizers.

Catalogs of the Cherry-Burrell Corporation, 427 W. Randolph St., Chicago 6, Ill.; the Creamery Package Manufacturing Co., 1243 W. Washington Blvd., Chicago 7, Ill.; the Taylor Instrument Companies, Rochester 1, N. Y.; and the York Corporation, York, Pa.

INDEX